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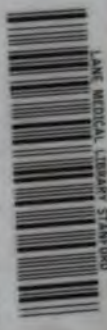
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PRINCIPLES AND PRACTICE OF SURGERY.

CHAPTER XIV.

DISLOCATIONS.

DISLOCATION (derived from the Latin words *dis* and *loco*) and LUXATION (from *luxo*) are interchangeable terms, and mean the separation and displacement of one articular surface of a joint from the other.

Luxations are less common than fractures. Nevertheless, for their recognition and treatment they demand even a more thorough anatomical knowledge than the latter. The student, in his dissections, should give particular attention to the study of the joints, observing their external contour, their form, the relation and movements of their articular surfaces, the disposition of their ligaments, the attachment of the surrounding muscles, and their relation to great blood-vessels and nerves,—a branch of study, I regret to say, which is sadly neglected by a large number of medical students.

Dislocations constitute a class of injuries which are easily overlooked unless the greatest attention is given to every case. I am constantly meeting with examples of luxations which for a long time have escaped detection; and I suppose my experience is not peculiar in this respect.

Dislocations are of two kinds, COMPLETE and INCOMPLETE.

A *complete dislocation* is one in which, the ligaments being torn or elongated, the articular surfaces of the bones are wholly removed from each other, so that the distal surface assumes an entirely new position, more or less contiguous to the other.

An *incomplete luxation*, sometimes termed a *partial luxation*, or *subluxation*, is one in which, although the relations of the articular surfaces of the joint are changed, some portions of them are still in contact with each other.

As examples of these two degrees of articular displacement, I may mention the luxations which affect the temporo-maxillary joint. When the condyles of the inferior maxillary bone are removed from the glenoid cavities of the temporal bones and thrust into the temporal fossæ, the luxation is a complete one. If, on the contrary, they are arrested on the eminentiæ articulares, the dislocation is incomplete.

Dislocations are also divided into TRAUMATIC, PATHOLOGICAL, and CONGENITAL.

Traumatic dislocations are such as result from external violence and from muscular action.

Pathological dislocations are those which are consequent upon morbid changes of structure in one or more of the components of a joint,—e.g., such as occasionally attend coxalgia or rheumatoid arthritis.

Congenital dislocations owe their origin to the operation of causes which affect the fœtus in utero.

Dislocations are further divided into SIMPLE and COMPLICATED; PRIMITIVE and SECONDARY; RECENT and OLD; UNILATERAL and BILATERAL; SINGLE and DOUBLE.

Dislocations are *simple* when no unusual injury of the bones, of the soft parts, or of the vessels or nerves, attends the displacement. They are *complicated* when an external wound is superadded to the luxation, or when fracture of one of the bones involved in the dislocation, laceration of important blood-vessels or nerves, or paralysis of the limb also exists.

Primitive and *secondary* or *consecutive* luxations are terms which have reference to the position of the displaced bone. Thus, when the head of the humerus is thrown into the axilla below the glenoid cavity of the scapula, it constitutes a primitive luxation; but if from muscular spasm, or in consequence of movements from other causes, the head is subsequently changed to a point beneath the coracoid process of the scapula, it forms a secondary luxation.

The terms *recent* and *old* do not refer chiefly to the time which elapses between the reception of the injury and the application for surgical aid, but rather to the difficulties which attend the reduction in different luxated joints. Thus, a luxation of the elbow-joint becomes old much more rapidly than a luxation of the shoulder. The distinction may exist even in dislocations of the same joint and of the same duration,—as, for example, where the determining cause has been barely sufficient to effect the luxation in one case, and in another case has been so violent as to produce extensive damage to the articulating surfaces of the bones and the adjacent soft parts, exciting intense inflammation and gluing the tissues together. In the first case, the restoration would be easily effected, and therefore the dislocation would be considered *recent*; in the latter, the pathological changes, rapidly induced by the inflammation, constitute sources of difficulty which ordinarily could only arise after the lapse of considerable time, and it would therefore require to be treated as though the dislocation were *old*.

Unilateral luxations are those in which the bone is dislocated on one side only. *Bilateral luxations* are those in which the bone is luxated on both sides. Thus, a dislocation of one condyle of the lower jaw is a unilateral displacement, while a dislocation of both condyles is a bilateral one.

Single dislocations are such as affect a joint on one side. *Double dislocations* are simultaneous luxations of the corresponding joints on both sides of the body.

Causes.—These are predisposing and exciting.

PREDISPOSING.—Among these may be enumerated the following:

1. *Form of the articulation.*—The ball-and-socket joints, from the plan of their construction, and from the extensive range of movement which they allow, are peculiarly liable to dislocation,—a fact which explains the frequency of scapulo-humeral luxations as compared with dislocations of the elbow-joint, which belongs to the class of ginglymoid or hinge articulations, whose movements are in a great measure limited to flexion and extension.

2. *Defective articular development.*—There are cases in which the head of a bone and its articulating cavity are imperfectly formed, the one being unusually shallow, and the other small or misshapen, to both of which conditions may be conjoined an elongation of the connecting ligaments. Such a conformation is peculiarly favorable to luxation.

3. *Absorption of a portion of the articulating surfaces or ligaments of a joint.*—This may be the result of a tumor, which, in its growth, comes in contact with the components of the articulation; or it may be produced by the attrition of the articulating surfaces under peculiar conditions. In this way the eminentiæ articulares are sometimes worn down on their sides from an irregular disposition of the teeth, causing the condyles of the inferior maxilla

to bear, in their movements, with unusual force against a limited portion of the glenoid cavities of the temporal bone.

4. *Fracture of an articulating cavity.*—When the head of a bone is driven against its articulating cavity with sufficient force to chip off a portion of the margin of the latter, luxation of the joint will almost invariably follow. The accident has frequently happened to both the hip- and the shoulder-joint.

5. *Muscular weakness.*—When the muscles about a joint become paralyzed or enfeebled from any cause, they allow the head of the bone to drop, and the weight gradually causes the ligaments to become elongated, and finally to allow the bones of the articulation to be luxated. An interesting case of this nature came under my notice, in which the scapular muscles of both sides had gradually lost their power and become atrophied, and thus allowed the humerus to become displaced. The scapula had wasted to a remarkable degree. Sir Astley Cooper describes two similar cases, in one of which the bone could be thrown out of place at pleasure.

A subluxation of the inferior maxilla, from muscular relaxation, is frequently noticed in weak, anæmic females.

6. *Articular disease.*—Large inflammatory transudations into the joints, causing elongation of the ligaments, or the reflex contraction of the muscles about an articulation already excited by arthritic inflammation, are both pre-determining causes of luxation. It is in this way that the patella and the bones of the leg are sometimes dislocated.

7. *Age.*—Dislocations are exceedingly uncommon in very young subjects,—a fact no doubt to be ascribed to the absence of great muscular power, the presence of the epiphyseal cartilages, and the general flexibility of the tissues composing the joints. These injuries are most common in the middle period of life, that is, between thirty and sixty, and diminish in frequency very rapidly after sixty. Of 912 cases of dislocation received into the Pennsylvania Hospital, 589 were in persons between the ages of thirty-five and sixty-five, only 44 occurring after the last-named period. Malgaigne, in an analysis of 643 dislocations, found 407 of this number to have taken place between the ages of thirty-five and sixty-five, and only 1 case under five years of age.

8. *Sex.*—Males are much more frequently the subjects of the accident than females. Of the 912 cases to which reference has been made, 88 per cent. were males. But, as regards age and sex, it must not be forgotten that the exposure incident to middle life and the character of its occupations exercise no small influence in determining the results reached by statisticians.

EXCITING CAUSES.—The exciting causes of dislocation are external force and muscular contraction. As in fractures, so in luxations, this external force may be either direct or indirect. If a person falls upon the shoulder and dislocates the head of the humerus, the bone is displaced by direct violence; when the force is applied to the hand or the elbow, and a similar result follows, it is an example of luxation by indirect violence.

The part which the muscles play in dislocation is not altogether clear. I apprehend it is a very subordinate one. For several years I was in the habit of demonstrating on the cadaver, to my classes in operative surgery, the facility with which luxations could be made by movements in which the muscles of course could not participate. That the muscles are capable, under an extraordinary stimulus, of producing dislocations, is indisputable. Several times have I seen such displacements of the head of the humerus, which took place in the night during epileptic convulsions.

Symptoms.—The symptoms of luxation are the following. There is *pain*, which, though not so acute as in fracture, is almost as difficult to endure. This pain is much increased on movement of the part. It is dull, and due to pressure upon the surrounding nerves, or to tension of the latter. Sometimes the discomfort complained of is *numbness*, as when the head of the humerus rests against the axillary plexus of nerves, or the head of the femur presses the great ischiatic cord.

Loss of function.—The limb or the part dislocated is no longer capable of executing the ordinary movements, but, as a rule, is rigid and fixed, and in this respect dislocation differs from fracture. This symptom is much more marked after the lapse of a few hours than immediately after the injury, *i.e.*, after the muscles have recovered from the paralyzing effects of the shock and the surrounding parts have become swollen.

Swelling is of little importance as a symptom. Like that in fracture, it is due to either blood or serum, or to both. When appearing quickly and to any great degree, it is usually from the effusion of blood.

Change in the length of the limb.—When the articulating surfaces are removed from each other this change inevitably follows, and consists in *shortening*, always in dislocations of the hinge-joints, and generally in those of the ball-and-socket form. To restore the limb to its proper length requires the employment of much greater force than is necessary to effect the same result in fracture.

Change in the direction of the limb.—This is due to the tension of the unbroken part of the ligaments, to the traction of certain muscles, and sometimes to the resistance of bony surfaces which normally are not in contact. Hence we have the elbow standing awkwardly off from the body in dislocation of the scapulo-humeral articulation, and adduction or abduction, with rotation, in luxations of the hip, etc.

Change in the exterior of the articulation.—Every joint presents certain topographical characteristics and has an expression peculiar to itself. These depend in a great measure upon the bones beneath, so that when the relations of the latter are changed, the outlines of the articulation are materially altered. Thus, normal rotundity is exchanged for flatness; bony processes which are scarcely noticed, as the acromion, become, in luxation of the shoulder, abrupt and salient; or the prominences may sink out of sight, as is the case with the trochanter major in luxation of the hip. Certain muscles also, in the direction of the displacement, become shortened and are bulging, while others, put upon a stretch, form tense cords beneath the skin. The head of the luxated bone may be often felt in an unusual position.

To recognize these symptoms fully, the corresponding sound side should always be exposed. When the swelling is great, the difficulties are enhanced; but even then a careful consideration of the points which have been enumerated will usually conduct the surgeon to a just conclusion, especially if he brings to his aid the use of an anæsthetic.

Crepitus.—This symptom, when present, is the result of the movements of tendons through inflamed sheaths or over bursæ, and of the friction of a cartilaginous surface against bone. It is very unlike that present in fractures, being soft and subdued, instead of rough and grating, as in the latter.

Discoloration, of itself, is a negative sign, but, as a rule, makes its appearance later than when due to fracture.

Diagnosis.—That the distinguishing signs between dislocation and fracture may be clear, they may be contrasted in the form in which they are placed below.

DISLOCATIONS.

Pain dull, though severe.
Diminished mobility.
Change in the external contour of the joint.
Crepitus, when present, is a soft or friction sound.
Require much force to overcome shortening; and when corrected, there is no tendency to recur.
Limb assumes a stiff, awkward appearance, projecting from the body.

FRACTURES.

Pain acute.
Preternatural mobility.
Not invariable: when it does occur, it is swelling, not flattening.
Crepitus rough and grating.
Little force required; the deformity recurring when that force is withdrawn.
Limb has a helpless, dangling, or limp appearance, approaching rather than receding from the body.

To distinguish dislocations from a separation of the epiphyses, we are to remember that the latter can occur only in young subjects, or at an age when

dislocations are among the rarest of accidents, and that crepitus is generally present in epiphyseal injuries.

Luxations may be distinguished from sprains by the facts that in the latter the movements peculiar to the joint, though painful and somewhat restricted, can all be made by the hand of the surgeon, and that the deformity consists of swelling alone.

Pathological Effects of a Dislocation.—These involve all the structures adjacent to the displaced bones. They may be divided into *immediate* and *remote*.

The *immediate* effects consist partly in the laceration, tension, etc., of a portion of the ligamentous apparatus of the joint. The capsular ligament is rent in the enarthrosis form of articulation, and sometimes other ligaments are torn, as the ligamentum teres in the hip-joint, and, in the ginglymoid joints, portions of those situated on one or more aspects of the articulation. In partial displacements, especially of the first kind (or ball-and-socket articulations), rupture of the capsule is not a necessary consequence; and perhaps the same may be true, occasionally, even in a complete luxation, when the capsule has been much elongated by muscular enfeeblement, although I am not aware of the existence of any specimen which establishes this statement. Holmes* mentions a preparation of a shoulder-joint in the museum of the College of Surgeons, dissected by John Hunter, three weeks after the reduction, and which is thought to be of this kind. In addition to the laceration of the ligaments, the tendons and muscles likewise suffer, being stretched, bruised, or torn. Small vessels are ruptured, principally veins, and extravasations of blood are found in the joint and among the tissues, in the neighborhood of the bones.

It is astonishing that the large vessels should so generally escape serious injury. That these may, in exceptional instances, be damaged, is seen in the case recorded by Professor Goldsmith,† where the head of the femur, which had been dislocated upon the pelvis above the acetabulum, lay in a large aneurismal dilatation of the femoral and external iliac arteries.

The nerves also are frequently subjected to pressure, stretching, and laceration, causing numbness, loss of power, and neuralgic suffering. The articular surfaces of the displaced bone or bones may be partially in contact or be widely separated,—conditions depending upon the intensity of the determining violence, on the degree of ligamentous laceration, and on the favorable disposition of muscles to act upon them. In two cases which I had an opportunity of dissecting, long after they had been reduced,—the one a shoulder, the other a hip,—scarcely could I discover a trace of the former injuries.

The *remote* effects of a luxation are of a very pronounced character. They reach both to the bones and to the soft parts, and they illustrate in a remarkable manner the power of accommodation to unusual conditions which resides in the body. When the bone remains unreduced, the old ligaments undergo wasting, and in time cannot be distinguished from the surrounding connective tissue; the head of the bone becomes atrophied and flattened, and its cartilaginous incrustations disappear, the surface below becoming smooth, hard, and polished. The articular cavity grows more shallow and loses its regularity, and may eventually disappear by the operation of two agencies,—the absorption of its circumference and the production of fibrous tissue or bone from the bottom of its cavity.

Wherever the head of the displaced bone rests, it produces for itself a cavity designed to supply the place of the old one. If it lies on a muscle, tendon, or fascia, there will be a rapid formation of condensed connective tissue, which assumes a cup shape; if it lies against a bone, a cavity will be developed, partly by absorption, and partly by a new deposit of osseous matter, the latter rising from the surface and forming a socket not unlike the original one, with an eburnated instead of a cartilaginous surface.

* Holmes's Surgery, vol. ii. p. 103.

† American Journal of Medical Sciences for July, 1860.

But the work does not stop here. The movements of the bone stimulate a further development of connective tissue, the interlacing fibres of which,

FIG. 898.



A new socket formed on the dorsum illi by the displaced head of the femur. *a.* External view of the new cavity. *b.* Its floor inside of the ilium.

becoming close and compact, serve to play the part of the old capsular ligament, the interior of which may, like other bursal sacs, furnish a fluid which will serve to lubricate the improvised joint. Sometimes the work is overdone, and the osseous deposit, which is piled up to form the socket, girdles the head or neck of the bone too tightly and interferes with its movement. The muscles, either stretched or shortened by the luxation, undergo a fatty change and become wasted; or, if torn so that the ends do not become united, they entirely disappear. The surrounding tendons, if torn, may, if much displaced, contract an attachment to other points; they may also have nodules of bone deposited in their substance. Inflammatory changes, in the mean time, have also been active, matting together the diverse structures of the part, and, most dangerous of all, gluing

large blood-vessels to the capsule investing the bone or its periosteum and exposing the patient to fatal hemorrhage when forcible efforts are made at reduction.

In old cases of unreduced ginglymoid joints, the repair is much less complete. The rapidity with which these changes are effected varies so much that no deductions of a practical nature can be made with any degree of certainty. In young persons it is certainly much more rapid than in the aged. Hilton, Hamilton, and others have seen very considerable progress made towards the formation of a new joint at three weeks, and as early as the eighteenth day. Brodhurst* describes a case of three years' standing, and Fournier a similar one seen ten years after the luxation, in both of which the cotyloid cavity of the innominatum was unchanged.

Prognosis.—In recent luxations, the reduction is usually accomplished without much difficulty; but some defect in the movements of the joint, and neuralgic pains, often continue for a long time after. I have seen many dislocated shoulders which ever after were disabled by inflammatory changes in and around the joint. The enarthrodial articulations are more easily displaced than the ginglymoid. The latter are made very secure by the processes and deep fossæ which belong to the articulating bones, and by the powerful ligaments and strong muscles which are disposed about the different aspects of the joint; so that to luxate such an articulation requires immense force, which is generally the measure of structural damage. The enarthrodial joints are at first more difficult of reduction than the ginglymoid; later the reverse is true.

Every year strengthens my belief that, as a rule, an articulation once dis-

* St. George's Hospital Reports, vol. iii. p. 68.

located is rarely entirely restored to its original condition, but ever after manifests some weakness, defect of movement, or disordered sensibility.

Treatment.—In the treatment of luxations, the same rule should be observed as in fractures, namely, to restore the bones to their proper functional position; to prevent a recurrence of the displacement; to combat any undue inflammatory symptoms which may arise, and to establish the natural movements of the part. Reduction should be made at the earliest possible moment. There are cogent reasons for such a course. One of the great obstacles encountered in reducing a luxation is muscular resistance. Immediately after such an accident the muscles are temporarily paralyzed, and consequently incapable of offering much opposition. The patient is also shocked, and, therefore, less sensitive to pain than hours after, when the initiatory stage of inflammation sets in, and the surrounding parts become swollen and tender.

THE MEANS TO BE EMPLOYED.

Manipulation.—One of the grand triumphs of modern surgery, it is sometimes said, is the substitution of address for brute force in the treatment of recent luxations. It will be found, however, that in the treatment of dislocations, as in many other branches of the art, we are only repeating and reducing to more practical forms the resources of the men of a former period. It is only after exploring the treasure-houses of these old-time workers that we begin to form any just conception of the immense fertility of expedients, the vast acquisition of knowledge, and the majestic sweep and reach of the thoughts which belong to the fathers of ancient medicine. Hippocrates distinctly speaks of reducing luxations by flexion and rotation of the injured limb; and during almost every succeeding century there have not been wanting writers who were entirely familiar with the same method. Richard Wiseman, that good old English surgeon, before 1676 was perhaps as familiar with this plan of reduction as Mr. Birkett in 1854. Over one hundred years ago, the fallacy of employing force alone for the reposition of dislocations was detected by Thomas Anderson,* in Scotland, and by Poteau,† in France, and manipulation employed as a substitute. Kluge's plan, in thigh dislocations, was to place the patient on his back, and, by flexion, abduction, and rotation, to restore the head of the bone to its socket.‡ Colombat claims to have been always successful in reducing luxations of the thigh, by making his patient lean over a table, and at the same time seizing its sides in order to keep the body fixed. While so placed, the leg was flexed on the thigh, and the latter drawn back and forth, and from side to side, until the bone slipped into place.§ Palletta's plan consisted in forcible flexion and abduction of the thigh.||

In this country, reduction by manipulation was first practiced by Dr. Physick, in 1811, and five years later by N. Smith, of New Haven.¶ But for the fullest exposition of reduction by manipulation the profession is indebted to Dr. W. W. Reid, of Rochester, New York, who in 1851 published** a detailed account of the plan which he pursues for the reposition of coxo-femoral dislocations. It consists, after placing the patient in the recumbent position, in first flexing the leg on the thigh, then adducting the limb, carrying it over the sound one, and, at the same time, upwards over the pelvis, by a semicircular sweep as high as the umbilicus. The knee is now to be gently abducted and rotated, when, as the limb is brought downward, the bone (if the luxation is dorsal) will glide into its articulating cavity.

* Anderson's Medical Commentaries, Edinburgh, 1776, vol. ii. pp. 261-264, Hamilton.

† Vidal de Cassis, Œuvres posthumes de Poteau, Paris, 1783, Hamilton.

‡ Dissert. de luxatione femoris, vol. ii. p. 241, Berol., 1823.

§ Op. cit., p. 706, Chelius.

|| Chelius, vol. ii. p. 242.

¶ Transactions of New York State Medical Society for 1856, p. 169.

** Buffalo Medical Journal, August, 1851.

The reduction of scapulo-humeral dislocations by manipulation was first reduced to systematic rules by Professor H. H. Smith, of Philadelphia.

Manipulation proceeds upon an accurate knowledge of all the anatomical components of a joint in its normal state. To employ it intelligently, the surgeon should also know, approximately at least, where the rent in the ligaments has been made, what ridge of bone will oppose, what muscles will resist, and what others can be won to his aid. In most cases, if acquainted with these facts, we shall succeed in restoring the dislocation.

ANÆSTHETICS constitute a powerful auxiliary to the reduction, and, unless there be contra-indications, they should always be employed as a preliminary measure. When the patient is seen at the time or within a few minutes after the dislocation has occurred, the necessity for their employment is less urgent. The boon which has been conferred on the surgery of luxations by ether and chloroform can only be appreciated by those who have, not many years ago, witnessed the reduction of a dislocation, such, for example, as that of the hip. The unfortunate patient was first subjected to the depressing effects of venesection while in the warm bath. Tartar emetic was next administered, until he was pale, sick almost unto death, and covered with a profuse perspiration. There was next attached to the injured limb a formidable machinery of compound pulleys, and extending and counter-extending bands, manned by rows of assistants, presenting altogether a scene strangely suggestive of mediæval torture. Even intoxication was resorted to in some instances to insure muscular relaxation.

Force.—Cases will be encountered in which manipulation will fail, and where force must be employed by other means, as in luxations of some weeks' standing, and in those which are called *old*. The appliances used in these

cases, with the manner of their application, will now be detailed.

POSITION OF THE PATIENT.—The recumbent position, on the back, upon a table, or on a narrow bed, is the one best suited for the reduction of dislocations of the lower extremity and of the shoulder,

whether by manipulation or by more forcible means. The others are most conveniently treated in the upright or sitting posture.

EXTENSION AND COUNTER-EXTENSION.—These operations are best effected by strong muslin sheets folded into cravat form, by bands of stout muslin, by long double or jack towels, by means of the Indian basket, and through the power of pulleys.

They should be made fast, as a rule, when it is possible, to the distal end of the dislocated bone; for example, above the elbow in luxation of the humerus, or above the knee in luxation of the hip. This adjustment leaves the forearm or the

leg free to be used as an arm of a lever. To prevent excoriation of the

FIG. 899.



The noose knot.

FIG. 900.



The noose knot applied to the arm.

soft parts, and to avoid slipping, it is common to envelop the part with a wet piece of muslin or chamois leather, and then to apply over this the band. There are two knots which do not slip, either of which may be made. The first is called *the noose* (Fig. 899), and is made by folding a sheet into cravat form, doubling it at the middle, and, after drawing each half partially through the noose, slipping it over the limb. (Fig. 900.)

The other knot is *the clove-hitch*, which will be best understood by looking at Figs. 901 and 902.

FIG. 901.



Clove-hitch.

FIG. 902.



Clove-hitch knot applied.

The *Indian basket*, which is a hollow cylinder woven of twigs of the willow or of strips of other wood (Fig. 903), constitutes a good instrument for securely grasping a part. By pressing together the ends of the basket the canal is enlarged, when it can be slipped over the limb, after which, the greater the extension the more firmly will it cling to the surface.

FIG. 903.



Indian basket.

FIG. 904.



Indian basket applied to the arm.

These contrivances are sometimes woven round a ring of iron at one extremity, the ring having two hooks or eyes for catching the extending bands, and may be applied to the arm or the thigh. (Fig. 904.)

The *rope-windlass*, as employed by Dr. Gilbert, is another appliance by which great power can be exercised. It can be quickly constructed by running a rope through the loop of either the noose or the clove-hitch, and securing the two ends together. When ready to apply the force, the end of the rope should be passed over a hook, or, before its ends are tied together, run through the eye of a staple. By twisting a stick placed between the two portions of the rope (Fig. 905) an unusual degree of power may be attained.

If it is desirable to obtain still greater mechanical power, the compound pulley (Fig. 906) can be used.

When these energetic means for extension are employed, the counter-extension

FIG. 905.



Gilbert's rope-windlass applied to the arm.

sion must be applied so as to fix the upper portion of the articulation, as by a

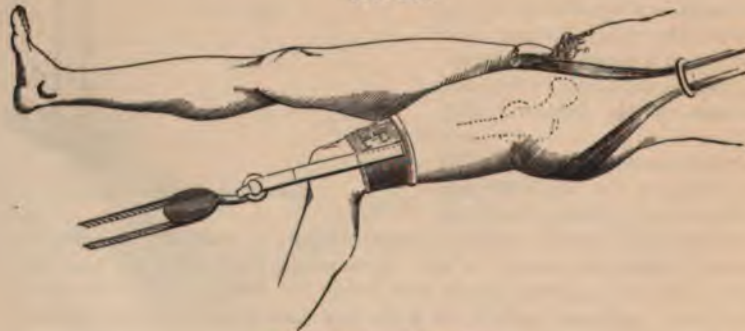
FIG. 906.



Compound pulley.

perineal band in dislocation of the hip. (Fig. 907.) The ends of the band

FIG. 907.



The application of the pulleys.

should be made fast to a staple or hook (Fig. 908), or to some other firm object, always observing to defend the skin against the effects of pressure.

Nothing answers the latter purpose better than a hank of yarn, when this can be had, placed under the counter-extending bands.

In order to measure the degree of force which may be used in restoring a luxation, or rather that the force may not be applied beyond the bounds of prudence, the French sometimes use an attachment to the pulleys, called the dynamometer.

An instrument of great power is one invented by Jarvis, commonly known as Jarvis's adjuster. It is a mechanism which exerts at the same time extending and counter-extending force. It is both costly and complex, and at present is very rarely employed. The tourniquet of Bloxam, at one time used in the reduction of dislocations, is another appliance which has in a good measure passed into disuse.

Dr. Davis, of New York, recommends india-rubber bands, which by their elasticity are well adapted for continuous extension. By the use of this material the doctor claims that he succeeded in reducing a luxation of the hip of fourteen years' standing.

This matter of *continuous extension* cannot be over-estimated, especially in restoring old dislocations. South relates a case of dislocated shoulder which had successfully resisted all the ordinary efforts for reduction, but which was reduced by the younger Clive by first fixing the shoulder and then suspending an ordinary brick from the hand over the side of the bed. On the day following, when he visited his patient, the head of the bone had resumed its place in the glenoid cavity. In a dislocation of the elbow-joint of six months' duration, continuous pulley-extension, protracted for eight hours, was attended with a like favorable result.

Mode of Using Force.—*First*, the force should be exerted in a proper direction. *Second*, it should not be made in a spasmodic or violent manner, but continuously, and with a gradual increase of power. *Third*, the part must be rotated and moved in all directions, so as to disengage the head of the bone from any lock or entanglement and break up such adhesions as may have formed between it and adjacent structures. And, *fourth*, when resistance of the muscles has been so far overcome as to allow the head of the bone to reach the level of the cavity from which it has been displaced, an adroit movement of the part must be made by the hands of the surgeon towards that cavity, while at the same moment the extending force, at a given signal, should be suddenly relaxed.

Should these measures fail, after being repeated and modified as the ingenuity and judgment of the surgeon will suggest, the question of dividing subcutaneously such ligaments, fibrous bands, tendon or tendons as are ascertained to prevent the restoration will come up; and its decision must be determined by a well-grounded assurance that the reduction is highly improbable without the operation.

Dieffenbach, Blumhardt, and others have, in this way, succeeded in restoring luxations of the shoulder and elbow of long standing. The operation is not unattended with danger to vessels and nerves, even in the most skillful hands, and can rarely be required.

When a dislocation is reduced, the fact may be known by the more or less perfect restoration of the natural outlines of the articulation, by the freedom of movement, and by the proper direction of the limb. The pain is diminished, and often the reduction is announced by a *distinct sound*. The use of anaesthetics may, however, prevent this last sign from being present, the bone, under the great muscular relaxation, going into place silently.

After-Treatment.—The bones once reduced, care must be exercised to prevent a recurrence of the displacement, by applying such retentive dressings as will be noticed under the head of Special Luxations. And, lastly, anchy-

FIG. 908.



Staple having a screw by which, after first boring a hole with a gimlet, it can be screwed to a post, or into the floor.

lois must, if possible, be prevented, by establishing at the proper time—say from ten to fourteen days—the various movements of the part, and renewing these movements daily, beginning very gently at first and using more vigorous ones later on.

Complicated Luxations.—Various circumstances may complicate a luxation. Some of these attend the accident; that is, the same force which determines the dislocation produces the additional injury which constitutes the complication. Others arise during the attempts at reduction. Some are serious, and others are comparatively unimportant.

FRACTURE.—A fracture coexisting with a luxation of the same bone adds no small difficulty to the case. But the course to be adopted is clear. The broken bone should be immediately set, covered with a bandage, and surrounded with a number of narrow splints, well padded, and bound securely to the part by a second roller. An anæsthetic should next be administered; and, when thorough relaxation is obtained, the manipulation necessary to the reduction of the luxation must be executed. Should it become necessary to attach extending bands, they must be applied over the splints, and, if practicable, above the seat of fracture. Should the fracture occur in the surgical neck of the humerus, the head of the bone being at the same time dislocated, of course the application of a splint previous to reduction is impracticable. Here the surgeon must rely, after etherization, upon well-directed pressure against the head of the bone, and, if successful in restoring it, afterwards apply the dressing appropriate to a fracture in this part of the humerus.

Compound Luxations.—The existence of an external wound communicating with the luxated joint is always a most serious injury. The cavity of the articulation may be opened by the soft parts being torn from without inwards, from the direct action of violence; but generally the reverse is true, the wound being caused by the dislocated bone being driven through the integuments. The dangers incident to so serious a complication are destructive arthritis, abscesses, pyæmia, erysipelas, necrosis, tetanus, hemorrhage, etc. Frequently the end of the bone is broken in addition to the other damage. As compared with simple luxations, compound luxations are quite rare. Dr. Norris, in his statistics drawn from the records of the Pennsylvania Hospital, found in 94 dislocations only 2 which were compound. Hamilton, in a collection of 166 cases, found 8 of a similar kind. The table of Dr. Alison* contains 784 cases of dislocations, 56 of which were compound.

The symptoms are so manifest that their detail is scarcely necessary. The white, moist, glistening cartilaginous surfaces of the bones, the flow of synovial fluid, recognized by its unctuous feel, perhaps the exposure of tendons, distortion of the part, and subcutaneous discoloration, sufficiently declare the nature of the injury.

TREATMENT.—This often demands the exercise of a well-instructed judgment. If the articulation is small, like a phalangeal or a metacarpo-phalangeal one, the parts should be replaced, well washed with the sublimate solution, the external wound carefully closed and covered with antiseptic dressings, and the hand placed upon a palmar splint, the finger being slightly flexed in the position which will render it most useful to the patient should ankylosis follow. If antiseptic dressing is not applied, the articulation, after its closure, should be covered with lead-water, and laudanum frequently applied, which may be renewed once in six hours, at the same time observing to disturb the parts as little as possible until the external wound is closed. After it is closed, gentle movements should be made, to restore, if possible, the function of the joint.

When the injury befalls large articulations, such as the ankle, the knee, the elbow, the shoulder, or the wrist, the case assumes the highest importance, and the line of conduct must be settled by a careful consideration of several points.

* Alison's Manuscript Tables of Luxations at the Pennsylvania Hospital.

By the careful use of antiseptic measures, rarely will it be necessary to amputate in compound fracture, even in the case of patients advanced in life, and with constitutions broken by intemperance and other excesses, which under old methods of treatment doomed the limb to amputation.

If the soft parts are extensively lacerated and the ends of the bones comminuted, excision will be demanded. The elbow-, the hip-, the shoulder-, and perhaps the ankle-joint, provided the soft parts are not too much torn, are best treated by excision. If the knee is the implicated articulation, amputation will be required, except in the case of children or in very young persons. Then excision should be preferred.

Where the principal blood-vessels are torn, with extensive damage to the soft tissues, amputation is proper.

Should there be two vessels supplying the parts below, as the tibials at the ankle, or the radial and ulnar arteries at the wrist, the rupture of the least important one, as of the anterior tibial, or of the radial, does not of itself necessitate amputation. The torn vessel should be tied, the remaining artery being equal to the supply.

If, after having considered the case in all its bearings, the surgeon decides to make an attempt to save the limb, the dressing must be made. The joint should be washed out with the sublimate solution, all vessels which continue to bleed must be tied, and, if possible, a fracture-bed provided. If there are any foreign matters adherent to the surfaces of the displaced bones, or to other parts, they must be carefully washed off with bichloride solution directed upon the wound by a sponge or from the nozzle of a syringe. Any loose fragments of bone must also be picked away with the fingers, or by the forceps, enlarging the external opening, if necessary, for this purpose. In the case of the ankle-joint, when the astragalus is detached or broken, the latter should be removed in its entirety.

At this stage a very important question presents itself with regard to the *ends of the bones*. How should they be dealt with before being returned? Should a portion of the articulating extremities be removed, or not? It has been considered, by some surgeons, necessary to cut away the protruding or exposed surfaces of one or both bones, to avoid the evils of inflammatory tension and secure ankylosis; and under old methods of treatment the course was a wise one. However, with the resources which we now possess to prevent the inflammatory sequences of traumatism, this operation, in my judgment, should be reserved for those cases of compound dislocation in which the ends of the bone have been broken, and present spiculæ, or irregularities of surface. A departure from this conservative course would be allowable in cases where many hours had elapsed before the patient could command surgical attention, and during which inflammatory swelling had occurred. In restoring the bones, even after the preliminary section, difficulty is sometimes encountered. Should, then, the ordinary manipulation for this purpose fail, the obstacle will probably be found in a constriction of the soft tissues about the bone. To overcome this, they may be stretched apart by the use of retractors. This failing, the opening should be enlarged by incision. When the resistance is due to the tension of certain muscles or tendons, an alteration in the position of the limb may secure their relaxation, or their division by means of tenotomy may be required. This not only facilitates reduction, but also renders the future treatment of the case more satisfactory.

The bones being restored, and drainage secured, the external wound must be carefully closed by sutures and then covered with the antiseptic dressings.

If the antiseptic treatment cannot be adopted, next in value will be irrigation with hot water. An exceedingly important part of the future management of the case is the securing of absolute quiet of the joint. This can be best effected, in the case of the knee articulation, by Packard's bracketed splint (see Fig. 837, vol. i. p. 1012), by the long fracture-box, or, what is often preferable, by recurring turns of a plaster roller including three-fourths of

the circumference of the limb and extending from a little distance above the ankle to the upper third of the thigh. A trap can be subsequently cut in the splint directly opposite to the wound, through which the latter can be dressed. The limb can be suspended in this dressing if the patient is disposed to be restless. This last appliance, or, if it is not accessible, that of the short fracture-box with bran, answers very well for the treatment of compound luxations of the ankle-joint when antiseptics has been neglected. The McIntyre splint is used by some for the same purpose.

When modern dressings have not been used and it is necessary to employ compression, it should be done by a Scultetus bandage,—an arrangement which admits of the removal of the strips and of their being replaced by others with a minimum disturbance of the parts. To effect this substitution, it is only necessary to attach to the end of each piece another of like size, which will take the place of the first as the latter is drawn away.

In compound luxations of the *shoulder-joint*, the arm may be placed upon an internal angular or trough-shaped splint, and fastened to the body by the turns of a roller.

When the *elbow* is the subject of the accident, the internal angular splint may be used, or a trough-shaped one, made of leather, wire, or plaster.

For the *wrist*, the ordinary palmar splint, employed in fractures of the carpus or metacarpus, answers every indication.

Occasionally the tibia is broken at the lower epiphysis and the diaphysis is at the same time thrust through the external wound. The accompanying cut (Fig. 909) represents an accident of this kind in a lad,—one of my hospital patients. The treatment in a case of this nature does not differ from

FIG. 909.



Compound separation of the tibia at its lower epiphysis.

that proper in compound luxations, except that in the former there is no necessity for cutting off the ends of the diaphysis.

During the period of traumatic fever, if such occurs, the excitement must be moderated by the exhibition of some febrifuge, as the neutral mixture, given at intervals of two or three hours, each dose containing the fortieth of a grain of antimony and the thirtieth of a grain of morphia. The nourishment for the first few days should consist of liquids. If the local inflammation exceeds the limits of safety, leeches should be freely distributed about the joint. When the inflammatory storm is past, it will be necessary to direct a generous diet and to administer quinine and iron. The articulation should be disturbed as little as possible. In cases where excision has not been practiced, passive movement should be made as soon as the danger of inflammation is past, or after a period of ten days to two weeks, according to the size of the articulation.

Under the most judicious management the joint may do badly. Erysipelas may supervene; abscesses may form, followed by profuse suppuration, by necrosis, and even by mortification. The system necessarily experiences the greatest disturbance in such a state of the parts. The pulse grows small and frequent; the tongue becomes dry and is streaked with patches of brown fur; the mind wanders; the surface is bedewed with a clammy perspiration; all the symptoms indicate a rapidly fatal termination.

To amputate in such a perturbed state of the body would only precipitate this result. If the patient can be tided over this danger by the use of stimulants, by nourishment and opiates, with the local use of warm poultices, and the prompt liberation of purulent accumulations as they form, the disease may be arrested at the point of necrosis, or a line of demarcation may be established should gangrene have taken place, and a general improvement may follow, foreshadowing a period, not very remote, when an amputation may be done with a good prospect of success.

Should gangrene set in, unassociated with the aggravated symptoms indicated above, amputation may be immediately resorted to.

Old Luxations.—In old cases of luxation, which have been overlooked, or in which only the ordinary efforts have been made for reduction, *should further attempts be made to correct the displacement?*

A person with a dislocated joint must always remain under a great disability, and no case ought to be abandoned, except from a full persuasion that further attempts would jeopardize the life of the patient. The fear that failure compromises professional reputation may urge a surgeon forward when his judgment would counsel otherwise; and I am well convinced that it requires no small degree of courage to say, "I have failed." But human life should never for one moment be placed in the balance against professional pride. So that while a tendon may be torn, a vessel lacerated, or even a bone broken, in lawful efforts at reduction, there can be no extenuation for that reckless use of force which, in the hands of a French surgeon, once tore off the forearm of an aged woman at the elbow, while trying to reduce an old luxation of the shoulder;* or, as in Flawbert's case, for lacerating the brachial plexus of nerves;† or for pulling off a phalanx in vain attempts to restore a luxated thumb.‡

It is difficult to determine the period at which the surgeon should decline interference in an old luxation. The dangers are certainly increased when there has been a history of much inflammation following the accident, thus gluing together the parts about the bone; and when the limb allows of but little movement. Smith, of New Haven, succeeded in restoring one shoulder after seven months, and another after ten and a half months. Breschet narrates the case of a hip reduced at seventy-eight days, also one of the shoulder at the eighty-second day, one at the ninetieth, and one at the ninety-eighth. Travers reduced a hip five months after the accident; Dr. Blackman, of Cincinnati, six months after; and Dr. Smyth, of New Orleans, nine months after. In the "Memoirs of the Royal Academy of Paris," vol. v. page 529, a case of dislocated hip is recorded which was reduced after a lapse of two years;§ and Brodhurst restored a shoulder on the one hundred and seventy-fifth day. Of thirty-seven cases collected by Dupuytren, ranging from one week to two years, all were reduced except two, which had been of the longest duration. The oldest one restored was of eighty-two days' standing. Other cases of like nature might be quoted. Sir Astley Cooper made three months the limit at which it was proper to attempt a reduction of the shoulder, and eight weeks for one of the hip. The use of anæsthetics must materially modify any such limitations; and when in addition to this our present knowledge of manipulation is considered, I have no hesitation in extending the period much further, always, however, apprising the patient of the possible danger attending the effort to reduce the bone, and never undertaking the task against his wish.

When the surgeon undertakes the reduction of an old dislocation, the operation requires a preliminary treatment. This consists in the daily use of manipulation, in which the arm is to be moved in all directions, gently and only for a few minutes at first, increasing the strength and the time of these motions as the limb is found to tolerate them. After each such treatment the shoulder should be surrounded with a lotion of laudanum and water. The objects of these measures are to break up, to soften, and to secure in some degree the removal of the bands of lymph by which the end of the bone is glued to the surrounding structures. When this is accomplished,—a result which may be known by the freedom with which the bone moves in its unnatural position,—an effort may be made to reduce the luxation.

* Gazette Hebdomadaire, 1864, p. 289.

† Répertoire Générale, tome iii.

‡ S. Cooper's First Lines of Surgery, 7th edit., p. 705.

§ Chelius's Surgery, South, vol. ii. p. 206.

This should be attempted first by manipulation, accompanied, if need be, by the subcutaneous division of clearly recognized resisting structures. Failing in this, some one or more of the different appliances for exerting greater power, already described, may be adopted, never, however, carrying the efforts beyond the bounds of prudence.

If, after these attempts, the surgeon fails to effect the restoration of the bone, there are still other resources at his command to remedy some of the inconveniences or disabilities connected with the displacement. Professor Edward Warren,* of Baltimore, in 1869, in the case of a female who suffered from the pressure of the head of the humerus on the axillary plexus of nerves, cut down upon the parts and excised the extremity of the bone by sawing through the surgical neck.

As the evil consequence attending the malposition of the bone is not so much due to its contact with the nerves and vessels of the axilla as to the pressure exerted on these during the movements of the arm, Dr. Mears, of Philadelphia, in a case of old luxation, divided subcutaneously with an Adams saw the surgical neck of the humerus, with the effect of giving to his patient a useful and painless arm.

During the winter of 1878, while making an effort to break up the adhesions of a luxation of the humerus in the person of an aged female, the bone snapped asunder at its surgical neck, with an audible noise. It occurred to me to establish in this case a false joint, by keeping up constant movements until the ends of the bone should have undergone those changes which would prevent their reunion. The result was highly satisfactory, as regards both the use of the arm and freedom from pain.

In instances, therefore, of ancient luxations of the humerus, where the prospect of restoration is one of great uncertainty, and where the attempt at reduction is not unattended with danger, the patient may be greatly benefited by either a subcutaneous section of the bone, as practiced by Dr. Mears, or by drilling it in the same locality, so as to render it sufficiently weak to admit of an easy fracture, in either case taking care to produce a pseudarthrosis by daily motion.

LACERATION OF VESSELS.—In the reduction of old luxations, aneurism, fatal hemorrhages, and extensive extravasations of blood have occurred from rupture of the principal vessels (generally the artery) of the part, as of the axillary in ancient dislocations of the humerus, and of the brachial in similar dislocations of the elbow. The treatment of such cases will be described under the head of Special Luxations.

LACERATION OF MUSCLES.—Even the great pectoral muscle has been torn across in violent efforts to restore an old luxation of the shoulder, and in another case, already alluded to, that of Guérin, all the muscles connecting the forearm with the arm were severed.

LACERATION OF NERVES.—Examples are not wanting of such an accident, even where portions of the brachial plexus have been torn by their roots from the spinal marrow. I doubt not that many of those cases in which the patient is not able, after reduction, to raise the arm towards the head, and in which the deltoid muscle becomes atrophied, are ascribable to some damage to the circumflex nerve, inflicted in efforts made to replace the bone. The consequences of such an injury are the loss of power and wasting of the muscles supplied by these nerves.

ABSCESSES.—These may follow the disturbance of the parts in the vicinity of bone which has been long dislocated, and must be treated on the same principles as abscesses from other causes, by evacuating the pus, at the same time taking care not to injure the blood-vessels.

* Baltimore Medical Journal and Bulletin, Sept. 1871, p. 532.

CONGENITAL LUXATIONS.

Congenital luxations most generally affect the hip-joints, and are due to causes very imperfectly understood, but which are *traumatic, nervous, or connected with an arrested development of the embryo.*

TRAUMATIC.—The traumatic variety will include those which are supposed to result from an injury inflicted upon the abdomen of the mother, or from a contraction of the uterus on the fœtus at a time when the limb is in some posture favorable to dislocation. If intra-uterine fractures occur in these ways, there is nothing incredible in luxations being determined by the same kind of violence. It is not improbable that some cases of so-called congenital dislocations have been produced by the accoucheur in forcible attempts at delivery. I once saw a case of luxated shoulder in a youth twelve years of age, which had escaped observation, and which, from the circumstances attending the case, had doubtless been caused in this way.

NERVOUS.—It is reasonable to suppose that those central influences which are concerned in producing club-foot, either through cerebro-spinal irritation concentrated on certain groups of muscles, or from paralysis, may be equally efficient in causing the displacement of a joint. Such was the opinion of Chaussier, Guérin, Breschet, Carnochan, and others.

DEFECTS OF FETAL DEVELOPMENT.—The defect may be partial or general. That is, it may be confined to the articulating cavity and the head of the bone, the former being very shallow and imperfect, and the latter small, flat, and deformed; or the vice may affect all the components of the joint, manifesting itself in distention of the ligaments, or their rupture, in an imperfect development of the bones, the cavity of the one being very shallow, or filled up with a soft fibrous or fibro-adipose material, and the head of the other misshapen, dwarfed, and flattened, and occupying a new but imperfect cavity. These dislocations are sometimes associated with monstrosities, and are also seen in cases of idiocy. Palletta and Dupuytren were both earnest advocates of the theory of embryonic defects of organization as the cause of congenital luxations. In these luxations the muscles also are very much changed both in structure and in form, being atrophied.

TREATMENT.—These dislocations are generally irremediable, yet occasionally something can be done towards remedying the defects.

Attempts may be made to restore the displacement by gradual and long-continued extension, applied either by elastic bands or by a weight suspended from the limb, as in fractures of the femur. If, after repeated attempts, the head of the bone cannot be thus conducted to its socket, and the obstacle to the reduction can be clearly referred to the resistance of a particular muscle, that resistance should be removed by subcutaneous section, after which the efforts to reduce may be renewed. Failing to bring the bone to its proper functional position, the next attempt should be, when the head of the bone is favorably situated, to establish a *new socket*, by carrying a well-padded strap around the pelvis and the two great trochanters of the femora, so as to fix the head of the bone firmly against the pelvic wall, and in this way to endeavor to produce what nature frequently does in old, unreduced luxations. As a necessary preliminary to this measure, Guérin made a number of subcutaneous scarifications through that part of the capsule between the head of the bone and the pelvic walls against which it rested, as well as through the other soft parts immediately around.

The inflammatory consequence of such incisions is to surround the articulating extremity with a mass of connective tissue, and in this way to moor it within very narrow limits, after which the work of forming the new cavity is commenced.

In two cases of congenital dislocation of the hip I was able to give some relief by an apparatus which, while it pressed the thigh-bones against the

sides of the pelvis, at the same time partially supported the weight of the body on the perineum, as is done by the perineal band attached to instruments worn for coxalgia.

SPECIAL DISLOCATIONS.

Dislocation of the Inferior Maxillary Bone.

Dislocation of the inferior maxillary bone may be regarded as a comparatively rare accident. Of 912 dislocations admitted into the Pennsylvania Hospital, only 9 were luxations of this articulation. Of this number 6 were males and 3 females, though generally the latter are in the majority. No case was noticed under twenty-five years of age, the largest number (5) occurring between twenty-five and thirty-five, and 1 at seventy-five years. Sir Astley Cooper has witnessed a single instance of the injury in a child. The absence of the alveolar processes in very young or very old inferior maxillæ, and the consequent obtuse angle between the body and the ramus of the bone, render dislocation of the temporo-maxillary articulation very improbable at the extremes of life.

The dislocation may be *bilateral*, *unilateral*, or *incomplete*, or, as the latter is sometimes called, a *subluxation*.

CAUSES.—The causes are predisposing and exciting. Among the *predisposing causes* may be mentioned a shallow glenoid cavity, the articular eminences being unusually low. These latter ridges may be materially altered by dental irregularities. This is very evident in a skull in my possession, in which the eminence on one side is worn down obliquely, and to an extent which must have rendered the articulation quite insecure. Preternatural relaxation of the ligaments and weakness of the muscles of mastication are also predisposing causes, and are induced by anæmia and feeble conditions of the general health.

The *exciting causes* are blows or falls upon the chin, gaping, biting upon hard substances, and even immoderate laughing. Instances of this dislocation are noticed by writers as having occurred under unusual circumstances. Sir Astley Cooper mentions one caused by an apple being forced between the maxillæ. Dorsey gives the case of a virago who, in a paroxysm of rage, and while scolding her husband, luxated her jaw. Hamilton records a case in which the dislocation occurred while a dentist was taking the impression of the mouth preparatory to constructing a set of teeth. Several times has the accident been produced while the roots of teeth were being pried out of their sockets. Dr. Coleman, of Trenton, New Jersey, reported to me, in a letter, the case of a girl seventeen years of age, who produced a luxation of the right condyle of the inferior maxillary bone by forcibly contracting the muscles of the jaw while making a strong effort to raise a window. The luxation was determined by a peculiar irregularity of the teeth. The late Professor Gibson was in the habit of relating in his lectures the case of a very penurious man who, on one occasion, had his jaw dislocated, and who, after its reduction, stoutly refused to pay his attendant's fee. A ridiculous anecdote told by the surgeon excited the laughter of the patient, and caused the bone to again slip out of place. Until the fee was paid down, all attempts at reduction were refused.

MECHANISM.—The exact manner in which dislocation of the lower jaw is accomplished has been the subject of considerable discussion by Nélaton, Malgaigne, Maisonneuve, Otto Weber, and others. I have many times produced the luxations on preparations of the head, and am convinced that the process is a very simple one. When the inferior maxillary is strongly depressed the condyles move forward, carrying with them the interarticular cartilages, and rising on the eminentiæ articulares. In this position of the bone the insertion of a part of the fibres of the masseter muscle is carried backward, and those fibres are consequently put upon the stretch. The

same is true of the anterior fibres of the temporal muscles. If, at this juncture, the depression of the jaw is slightly increased from any cause, the condyles will break through the front of the capsular ligament, and be suddenly pulled over the articular eminences by the contraction of the external pterygoid muscles, assisted by the tense portions of the masseter and temporal muscles. The muscles of mastication are very irritable, are all supplied from the same trunk, viz., the motor branch of the fifth pair of nerves, and act very energetically upon the application of any stimulus. The condyles, once over the articular eminences, take their position directly in front of the latter, being drawn up towards the temporal fossæ by the temporal, pterygoid, and masseter muscles. The coronoid process, in most instances, barely touches the malar bone, and the external lateral ligament is only partially torn.

Bilateral Dislocation.—When both condyles are removed from their articulating cavities, the front teeth of the maxillæ will be found separated to the extent of an inch (the interval may be more or less); the mouth remains open; the dental arch of the lower jaw is in advance of that of the upper, giving to the chin an unduly prominent or elongated appearance; the articulation is indistinct; the saliva dribbles from the mouth, in consequence of the pressure upon the parotid glands exciting increased secretion; the prominences of the condyles in front of the ear, which, when the bone is in

FIG. 910.



Position of the lower jaw in bilateral dislocation.

FIG. 911.



Bilateral dislocation of the lower jaw.

its natural position, can be distinctly felt, disappear, and in their place appear depressions, while immediately behind the malar bone a slight elevation exists, caused by the coronoid process and the tendon of the temporal muscle. (Figs. 910 and 911.) The jaw is fixed, and the pain is usually severe, in consequence of pressure on branches belonging to the sensitive part of the fifth pair of nerves.

Unilateral Dislocation.—In this luxation only one condyle is displaced, in consequence of which the lower jaw is carried towards the opposite or uninjured side, giving to the chin a twisted appearance. The incisor teeth of the lower jaw on the sound side are found external to those of the upper jaw, the maxillæ are somewhat separated, and the mouth is partially open. In addition to these signs, the jaw is fixed, and a depression will be found in front of the ear on the side of the displacement, as well as an unusual prominence of the condyle on the sound side. (Fig. 912.) It must be observed, however, that all of these distinctive characteristics of unilateral luxation are not always present, and, consequently, the injury may exist without its nature

being altogether clear. The fixed state of the maxilla and the depression in front of the ear will, however, serve to remove any doubt.

FIG. 912.



Unilateral dislocation of the lower jaw.

functional position below the zygomatic line,—signs which exist in the latter injury. It can be established also by the chin, in fracture, falling to the injured side, while in dislocation of one condyle the chin inclines to the opposite side. Trismus and paralysis, except in the rigidity of the jaws in the first, and the obliquity of the face in the second, have so few points of resemblance that it is very improbable they would ever be confounded with luxation of the jaw.

PROGNOSIS.—The reduction of a dislocated jaw is usually easily accomplished; and though the articulation is rendered less secure by the occurrence of the displacement, yet its movements are not materially affected. Even in instances of non-reduction, the deformity and the disability immediately following the accident measurably disappear in time, and a reasonable degree of movement and of power is acquired over the jaw. Quite a number of old dislocations of the inferior maxilla have been successfully treated. Physick restored one nine weeks after its occurrence; Pollock, one after the lapse of four months; Donavan, one ninety days following the injury; and Demarquay and Stromeyer, each one, the first eighty-three, and the last thirty-five, days succeeding the dislocation.

TREATMENT.—The patient being seated on a low chair or stool, an assistant standing behind to support the head, the surgeon takes his place in front, and, having the thumbs well protected by a shield of leather or by a linen handkerchief, passes them back until they rest on the molar teeth on each side, with the finger planted along the outside of the base of the jaw. (Fig. 913.) This is done in order to disengage the condyles from their unnatural position within the zygomatic arch, thereby overcoming the contraction of the masseter, the anterior part of the temporal, and the internal pterygoid muscles. Then, by elevating with the fingers the anterior portion of the bone, the condyles will be drawn into position by the posterior portions of the temporal and the deep masseter muscles. The return of the bone into place is announced by an audible sound, and it occurs with such suddenness

Subluxation.—Under this term Sir Astley Cooper describes a fixed condition of the jaw, which he supposed was due to the interarticular cartilages slipping behind the condyles and locking them upon the articular eminences. The nature of this displacement has never been verified by dissection. Those who are the subjects of this luxation are generally young persons having a very feeble and relaxed muscular system, with little constitutional stamina. The symptoms of the disarrangement are a sudden immobility of the jaw, coming on while chewing or biting upon some hard substance, with a slight separation of the incisor teeth.

DIAGNOSIS.—The only injury with which luxation of the lower jaw can be confounded is a fracture of the neck of the condyle. The distinction can be established by the mobility of the jaw and the presence of the condyloid prominence in its

and force that, unless the operator is careful to shift his thumbs over to the sides of the gums, they may be severely contused between the teeth.

In luxations of long standing, if the thumbs are not found to be sufficiently powerful to effect the necessary depression, two wooden levers should be employed, counter-pressure being at the same time applied beneath the chin. Should any unusual resistance be encountered, or if the patient is very sensitive to pain, the reduction will be greatly facilitated by administering ether.

Other methods have been employed to restore these displacements, which, in most cases, are neither so effective nor so simple as the one described. Sir Astley Cooper thrust a cork between the molars on each side, and then forcibly raised the chin. M. Nélaton, not deeming it essential to raise the chin, and believing that the chief resistance to be overcome was that of the lock between the coronoid process and the malar bone, after directing the jaws to be widely opened, planted his thumbs against the coronoid processes, either within or without the mouth, and pressed them forcibly downward and backward. It was in this way that this distinguished surgeon succeeded in restoring a luxation of the temporo-maxillary articulation which had successfully resisted repeated attempts made by others at reduction.

After the bone has been replaced, the jaw should be supported for eight or ten days by a Barton bandage or by the sling of the chin. (Fig. 914.)

For restoring a unilateral dislocation of the jaw, the same rules are to be observed as are applicable to the bilateral displacement, only applying the force to one side instead of to both.

The *subluxation* is easily corrected by introducing a case-knife between the teeth and prying the jaws apart. In this way a subluxation was immediately reduced by a medical friend after having passed unrecognized for four weeks. The plan of Nélaton for the reposition of bilateral luxations, by pressing the coronoid process downward and backward, may also be employed with success.

NOISY MOVEMENTS OF THE TEMPORO-MAXILLARY JOINTS.—This defect is a very common one, and is a source not only of mortification to the patient, but of considerable annoyance to persons who may be near. It consists of a snapping sound which is heard during the movements of the jaw in chewing. It is caused by the condyles mounting the articular eminences when the jaw is depressed, and then suddenly slipping back during its elevation. It is always an evidence of a lack of tonicity in the muscles of mastication, the relaxation of which causes the temporo-maxillary ligaments to become elongated, and in this way allows the joint surfaces to fall apart. The local difficulty is only a symptom of general feeble health, and is best corrected by the administration of quinine, iron, and strychnia, and a resort to good food, cold bathing, electricity, and a life in the open air. Both the vice of subluxation and that of noisy movements may degenerate into spontaneous luxation,

FIG. 913.



Reducing a dislocated lower jaw.

FIG. 914.



Dressing after reduction of the lower jaw.

in which one or both condyles slip out of the glenoid cavities in the most unexpected manner.

When this condition is threatened, in addition to the treatment already prescribed, the jaw should be protected by a sling of the chin, fastened with tapes passed over the head.

Cramp of the Jaw.—After gaping, the lower jaw is sometimes prevented from being closed against the upper one by a spasmodic contraction of the anterior belly of the digastric muscle, which can be felt beneath the chin as a hard, painful ridge. It is possible that this slightly-depressed state of the jaw may occasionally be induced by the temporary arrest of the tendon of the same muscle, in the pulley by which it is looped to the hyoid bone. Most persons have at some period in their lives experienced this painful condition. It is probably the same affection as that which was described by Benevoli, and noticed by Hamilton in his work on "Fractures and Dislocations;" though I have never witnessed the swelling of the temporal muscles described by the Italian writer.

The spasm is easily removed by friction with the finger over the rigid muscle. The disturbance is generally limited to a single muscle.

Congenital dislocations of the inferior maxillary bone are exceedingly rare. A very remarkable instance of this kind has been recorded by Mr. R. W. Smith, in which the dissection showed a very imperfect development of all the components of the joint on the affected side, including bones, interarticular cartilages, ligaments, and muscles.

The usual signs of unilateral or bilateral luxation are absent in this class of dislocations; but there is, nevertheless, a singular absence of facial symmetry, the face being rotund on the sound side and hollow on the affected side, giving rise to a marked deformity of the features.

DISLOCATIONS OF THE RIBS AND THE COSTAL CARTILAGES.

Costo-Vertebral Dislocations.

The ribs, with two exceptions, articulate posteriorly with the bodies and the transverse processes of the vertebræ, and anteriorly with the costo-sternal cartilages. The depth of the vertebral extremity of the ribs, their firm articulations, and the protection they derive from their position under a considerable mass of muscular tissue, render a dislocation in this locality extremely improbable. The possibility of such a displacement, however, has been certainly established.

Mr. Poland, in his article on injuries of the chest, has collected together nine cases of costo-vertebral dislocation. In seven of these the diagnosis was verified by post-mortem examinations. The dislocated ribs were, in one case, the twelfth on each side, and the eleventh on the left side. In another case, it was the fourth left rib. In the third, two ribs were displaced, either the sixth and seventh, or the seventh and eighth. In a fourth, the tenth rib was completely luxated, and the eleventh partly so. In a fifth case, the two last ribs on the left side were displaced; and in two other instances the seventh rib was dislocated.

In a man who had received a severe railroad injury, and who died from laceration of the lung, I found two ribs detached from their vertebral articulations, and each of them was also broken.

In three of Poland's collections the dislocation was accompanied either by fracture of some of the ribs or by other injuries.

There are no signs characteristic of a costo-vertebral dislocation. In the observed cases, the only symptoms present were those of severe contusion, and, in one instance, of an indentation in the ribs supposed to be displaced.

The treatment in a case apparently of this nature will not differ from the treatment proper in fracture of the ribs.

Costo-Chondral and Chondro-Sternal Dislocations.

Dislocations of the anterior extremities of the ribs from their cartilages are also very uncommon injuries, quite as rare as those met with at the costo-vertebral articulation; and the same may be said of chondro-sternal luxations. Mr. Poland has only been able to collect four cases of the former and five cases of the latter displacement. Hamilton records one,—a dislocation of the fourth chondro-sternal cartilage,—which was under the care of Dr. Flagg, of St. Paul, Minnesota, and which is not included in Poland's table.

In a lad ten years of age, whom I saw with Professor Penrose, several of the true ribs had been disconnected from their cartilages. The boy had sustained a number of fractures in different parts of the skeleton, and was paralyzed in the lower extremities. Professor Gross has met with a number of costo-sternal and chondro-sternal dislocations.

The signs of these displacements are pain, a preternatural prominence in the position of the displaced rib or cartilage, undue mobility, crepitus, and sometimes a disturbed respiration.

The treatment consists in restoring the displacement by drawing the shoulder backward, so as to put the great pectoral muscle on the injured side upon the stretch, at the same time extending the trunk. If this does not succeed, ether should be administered, in order that the patient may have the benefit of the long inspirations usually induced by this agent, and which, fully dilating the chest, favor the reduction.

After the reduction, it will be necessary to surround the thorax with a broad bandage.

The violence which causes these dislocations gives rise to very serious chest complications, which will demand the attention of the surgeon.

Chondral Dislocations.

The cartilages belonging to the sixth, seventh, and eighth ribs have opposed articular surfaces, connected together by capsular ligaments. These joints have in a very few (3) instances been displaced.

In one of these cases the luxation occurred during the struggle consequent upon a fall backward from a chair.

A depression corresponding to the displaced cartilage and an unusual prominence of the one above will indicate the nature of the injury.

The reduction will require that the displaced cartilage be liberated from its position beneath the one above, which can be effected by pressing the latter upward and backward. After the luxation is restored, a compress should be applied over the articulation, and the chest enveloped in a broad bandage, or a few strips of adhesive plaster applied over the seat of the injury and for some distance above and below it.

Dislocation of the Bones of the Sternum.

Dislocation of the bones of the sternum is the result of such extraordinary violence that the accident is frequently followed by death. Malgaigne gives ten cases of traumatic dislocation of the sternum. The patients were all males, five of whom died from the injury. Dr. John Brinton, of Philadelphia, has brought together and analyzed thirteen cases, one of which occurred in his own practice. Of these, seven died and six recovered. The luxation takes place between the manubrium and the body. It is produced by direct force, or by extreme flexion of the body.

The displacement will be determined by the manner in which the separa-

tion is brought about. When the determining force is received upon the body of the sternum, the latter will be driven beneath the manubrium; when caused by strong flexion of the spine, the first piece will be carried in front of the second.

Poland says that several cases of this luxation have been seen during the past thirty years at Guy's Hospital. In none of these could reduction be accomplished; but when the complications were not too serious, the patients generally did well.

The same author has tabulated 14 cases of this dislocation, with 6 deaths, 5 cures, and in 3 the event was unknown.

The *signs* of the dislocation will be evident, as the parts affected are accessible both to the eye and to the touch.

TREATMENT.—Although, in most instances, the reposition cannot be effected, yet no case should be allowed to pass without an attempt to restore the bones to their proper position. A pillow should be rolled into a cylinder and placed beneath the trunk so as to extend the body, while the head is at the same time carried well back; while in this position traction or pressure should be made upon the luxated bone. An anæsthetic may also prove a useful adjuvant to these measures.

If successful in adjusting the bones, a bandage should next be carried around the chest, to give greater security to the parts. The severe concussion often sustained by the thoracic contents in these injuries of the sternum and of the cartilages will demand attention. Hot flaxseed-meal poultices applied over the front of the chest, and renewed every six hours, prove of the greatest value in preventing or resolving congestion of the viscera of the chest. And when there is much pain, opium in some form should be administered. If, notwithstanding these measures, inflammatory complications arise, they must be combated by the local abstraction of blood and by moderate purgation; or, when dyspnœa and pain are urgent, by general blood-letting.

Dislocation of the Ensiform Cartilage.

Malgaigne has collected two cases of dislocation of the ensiform cartilage. In both the displacement was caused by force directly applied to the epigastrium; and in both the injury was followed by severe pain in the region of the stomach, and by difficult respiration and vomiting, which were only removed by the reduction of the cartilage. This was effected, in one of the cases, by pressing the finger beneath the cartilage and raising it into position. In the other case, reduction was effected by dividing the overlying tissues, including the peritoneum, along the side of the cartilage, and then hooking it into place.

The dyspnœa attending this accident must be due, I presume, to irritation of one or both of the phrenic nerves.

DISLOCATIONS OF THE VERTEBRÆ.

Aside from positive demonstration by dissection, it would seem almost impossible that the pieces of a structure like the spinal column, bound together by numerous articulations and powerful ligaments and cartilages, could be disjoined by any force short of that which would work complete disorganization. Abernethy denied the possibility of such a dislocation. But, though this accident is exceedingly uncommon, a sufficient number of cases have been observed to establish the existence of this injury beyond a shadow of doubt.

These dislocations are often conjoined with fracture. The fatality attending them is almost universal,—a result which might be anticipated from the damage which must, in such luxations, almost inevitably be inflicted upon the spinal cord.

In fractures of the spine, the fragments are frequently only slightly dis-

placed, and the spinal marrow may escape any serious lesions, other than those which may ensue from inflammatory changes. But in dislocation we rarely find so favorable a disposition of the displaced vertebræ.

These dislocations may be arranged, according to the anatomical divisions of the spine, into those of the cervical and those of the dorsal vertebræ. I am not aware that any well-authenticated instance of an uncomplicated dislocation of a lumbar vertebra has been met with.

Dislocations of the Cervical Vertebræ.

The cervical region of the spine, in consequence of the degree of movement existing between its components, and also the superficial character of the articulating processes, furnishes the largest number of vertebral dislocations. The collections of Schranth, Malgaigne, and Bryant comprise in the aggregate 80 cases of cervical luxation, while a considerable number may be found scattered among various medical journals. Uncomplicated dislocations of the cervical vertebræ form a large percentage of the lesions affecting the bones of this region.

The region embraced between the fourth and sixth cervical vertebræ, inclusive, seems to be exceptionally vulnerable, as will appear from the cases which I tabulate below. All those marked with an asterisk were verified by a post-mortem examination.

Table of Dislocations of Cervical Vertebræ.

Name of Medical Attendant.	Age.	Sex.	Cervical Vertebra.	Treatment.	Result.	Authority.
Daniel Ayres.	Adult.	Male.	5th bilateral.	Reduced.	Recovered.	New York Jour. Med., vol. ii. p. 9, 3d Series.
W. W. Byer.	.....	Girl.	4th.	"	"	Pacific Med. and Surgical Jour., Sept. 1858.
W. H. White.	.....	Boy.	5th bilateral.	"	"	Boston Med. and Surgical Jour., vol. v. p. 174.
D. W. Cheever.	Adult.	Male.	5th and 6th.	.....	Died in 50 hours.	Boston Med. and Surgical Jour., June number, p. 75.
Dr. Rogers.*	.....	Female.	5th.	.....	.....	New York Med. Record, vol. iii. p. 478.
W. H. Farrington.*	Adult.	"	6th.	.....	Died 6th day.	Phila. Medical Times, vol. iv. p. 215.
R. J. Farquharson.*	"	"	4th.	.....	Died in 25 hours.	American Jour. Med. Sciences, vol. lxvi. p. 281.
Robert Reyburn.*	"	Male.	5th unilateral.	Reduced.	Died in 15 days.	American Jour. Med. Sciences, vol. lxii. p. 110.
W. G. Clark.*	"	"	5th and 6th.	.....	Died in 36 hours.	American Jour. Med. Sciences, vol. xxvi. p. 85.
Dr. Thaxter.*	"	"	5th.	.....	Died 4th day.	Boston Med. and Surgical Jour., vol. x. p. 349.
Dr. Gay.*	"	"	5th.	.....	Died 11th day.	Boston Med. and Surgical Jour., vol. x. p. 275.
Dr. Jackson.*	"	"	5th and 6th.	.....	Died 3d day.	Boston Med. and Surgical Jour., vol. lxv. p. 120 (Old Series).
E. K. Sanborn.*	"	"	5th.	.....	Died 8th day.	Boston Med. and Surgical Jour., vol. xiv. p. 69.
E. K. Sanborn.*	.....	.....	5th and 6th.	.....	Died 3d day.	Boston Med. and Surgical Jour., vol. xiv. p. 69.
G. W. Norris.*	Adult.	Male.	5th.	.....	Died 3d day.	American Jour. Med. Sciences, vol. i. p. 336 (New Series).
Lente.	.....	.....	5th.	.....	Died 5th day.	New York Jour. Med., May, 1850, p. 284.
Lente.	.....	.....	5th.	.....	Died in 2 hours.	New York Jour. Med. May, 1850, p. 397.
W. H. Horner.	Adult.	Male.	4th.	.....	.....	American Jour. Med. Sciences, April, 1843.
Dr. Shuck.	"	"	.....	Reduced.	Recovered.	American Jour. Med. Sciences, vol. ii. July, 1841, p. 207.
Dr. E. Maxson.	Child.	.....	5th and 6th.	"	"	Buffalo Medical Jour., Jan. 1857, p. 479.
Dr. Hickman.	.....	.....	4th and 5th.	"	"	Ohio Med. and Surg. Jour., 1854-57, vol. vii. p. 345.
Schranth.	.....	.....	4th.	"	"	American Jour. Med. Sciences, May, 1848.
Mr. Frigonneau.	.....	.....	5th.	"	"	Malgaigne, Trait. Disloc., p. 363.
Dr. Purple.	.....	.....	5th and 6th.	.....	"	New York Jour. Med., May, 1853, p. 319.

These dislocations may be *complete* or *incomplete*. They may take place in a forward or in a backward direction. When the articulating processes of one side are displaced, the luxation is *lateral*. When those of both sides are displaced, the luxation is *bilateral*. In treating of these dislocations, they may be arranged into those which take place below, and those which take place above, the second cervical vertebra.

Dislocations below the Second Cervical Vertebra.

A luxation may occur at any of the articulations between the second cervical and the first dorsal vertebra. The direction of the displacement is generally *forward*; that is, the vertebra below the one displaced remains *fixed*, while all the vertebræ above are carried in an *anterior* direction. (See Figs. 915 and 916.)

FIG. 915.



Forward dislocation between the fourth and fifth cervical vertebrae. Front view.

FIG. 916.



Side view of the same, being a vertical section, exposing the injury to the spinal cord.

The manner in which these luxations occur would seem to show that, for their production, it is necessary that great violence should be applied either to the head while it is bent forward towards the breast, or directly to the back of the neck. In the unilateral or one-sided displacement the force is supposed to act more on one side—the affected side—than on the other. Or this luxation may result from the spine being violently twisted.

In a *complete* luxation, the ligaments uniting the articular processes are torn, the lower processes of the upper or displaced vertebra being placed in front of, or behind, the upper processes of the lower or stationary vertebra, as the case may be. The posterior common vertebral ligament gives way, and the intervertebral cartilage is ruptured. The anterior common ligament has been found to retain its continuity, though detached for some distance both above and below the luxation. In addition to these lesions, the cord may be contused, crushed, or even severed. Blood is also extravasated both within and without the spinal canal.

SYMPTOMS.—Though in many instances there must remain some doubt as to the exact nature of the injury, yet in well-marked cases of this luxation the head assumes a certain position, dependent upon the direction of the displacement; that is, it will be flexed upon the breast when the luxation is backward, extended or carried backward when the luxation is forward, and turned to one side or the other when it is a lateral luxation. A break in the line of the spinous processes may also be detected, the luxated vertebra and all above it being found either in front of, behind, or to one side of those below the seat of injury. The same want of regularity which is noticed in

the position of the spinous processes may be seen to exist to some extent also in the anterior surfaces of the bodies of the vertebræ, by examining the posterior wall of the pharynx.

As in fracture, so in dislocation of the cervical vertebræ, paralysis, more or less complete, follows the injury, affecting all the parts below the seat of displacement. Death, after a lesion of this nature, may follow almost instantly, especially when the luxation is above the origin of the phrenic nerves; or it may be delayed for a few days, rarely exceeding two. Of 11 cases which appear in the table and were verified by post-mortem examination, all died at periods ranging from twenty-five hours to eleven days, except in a single instance, where the patient lingered fifteen days.

TREATMENT.—There has been much diversity of opinion as to the propriety of making any attempts to reduce dislocated vertebræ. But the number of instances in which efforts of this kind have proved successful has multiplied to a degree which now leaves no doubt about the propriety of surgical interference. Of the 9 cases noted in the table, which were believed to have been genuine examples of dislocation, in which reduction was practiced, all save one recovered; while in the 15 cases in which no efforts at reduction were made, all died except two, viz., those recorded by Purple and Horner. It is worthy of note that in no case of luxation below the second cervical vertebra have the vertebral vessels been injured.

In a complete dislocation of the vertebræ, the reduction is effected by placing the patient on a firm table in the recumbent position, and, after passing folded sheets obliquely across the shoulders and securing their ends to the table, making extension with the hands placed under the chin and behind the occiput, varying the direction of the head according to the displacement.

When the prominence of the displaced vertebra can be felt through the pharynx, the reposition can be facilitated by making pressure, with the finger introduced through the mouth, against the projection, but at the same time keeping up the traction in the head. In like manner pressure should also be exerted upon any posterior prominence which can be discerned when the luxation is backward.

When the displacement is unilateral, in addition to the extension and counter-extension, the inclination of the head towards the sound side should be first slightly increased, in order to disentangle completely the luxated processes. Afterwards the head should be rotated towards the injured side. The use of an anæsthetic will materially contribute to the success of any efforts made with a view to reduction.

Dislocations above the Second Cervical Vertebra.

The dislocations which occur above the second cervical vertebra are the *occipito-atloid* and the *atlo-axoid*.

Occipito-Atloid Dislocations.

In the three dislocations of the occipito-atloidean articulation which have been reported, the injury was produced by violence applied to the back of the head or neck. In the first case (that given by M. Lassus), a bale of hay fell from a height, striking upon the back of the neck a man whose head, at the time of the accident, was bent over upon the breast. In the second case, recorded by M. Palletta,* the dislocation was the result of a fall, in which the back of the man's head, most probably, first struck the ground. In the third (M. Bouisson's case), the patient was a boy, who had been crushed under a wagon. In each instance the injury proved fatal.

The lesions in all three of these cases were different. In the first, there was an almost complete separation of the condyles of the occipital bone from

* Cooper's Surgical Dictionary.

the cup-shaped cavities of the atlas, with laceration of the vertebral vessels. In the second, the atlas, though displaced, was not wholly separated from the occipital bone. And in the third, the dislocation was unilateral, the right half of the posterior arch of the atlas being forced against the medulla oblongata.

Atlo-Axoid Dislocations.

The peculiar nature of the articulation between the atlas and the axis, admitting of extensive rotation, renders it particularly liable to injury from violent or extreme twists of the head, or from similar movements of the body when the head is fixed. Luxation of the atlo-axoid articulation may take place in several ways. When the odontoid process is broken, the atlas may slide backward from the axis, carrying with it the process, and crushing the upper portion of the spinal cord. Or the odontoid ligament may be ruptured, together with some fibres of its transverse portion,—a lesion which will allow the odontoid process of the axis to slip beneath it, even though the transverse ligament may remain unbroken. Again, the atlas may be rotated upon the axis to a degree which will cause rupture of the articular ligaments and a displacement in which the atlas will rest obliquely across the axis, the lower articulating process of the atlas being in front of, and the other atloidean process behind, the axoid process. And, lastly, the dislocation may be limited to the articulating processes of one side. Mr. Cruikshank* and Dr. Thompson† have each given an instance of spontaneous luxation of the processus dentatus.

Atlo-axoid displacements are the result of falls upon the head, strokes or blows upon the back of the neck, sudden and extreme twists of the head, or twists of the body when the head is held motionless. It was probably in this last-mentioned way that the axis was displaced from the atlas, causing the instantaneous death of a child while being raised by the head and struggling to release itself, in a case mentioned by Petit.

There is also a form of displacement which is due to caries, and is now and then met with among scrofulous children.

SYMPTOMS.—The symptoms of an atlo-axoid luxation must necessarily be very vague and uncertain. Should the head be found twisted to one side and incapable of rotation, with a bent state of the neck, and it were known that a sufficient cause of luxation had been applied, there would be presumptive evidence of a unilateral displacement, provided, however, no deformity could be felt at a lower part of the cervical region.

The *prognosis* in injuries of this nature must be exceedingly unfavorable, in consequence of the paralysis following the damage done to the medulla or to the cord. Cases, however, are recorded in which the displacement was reduced and recovery followed. One of these was under the care of Desault. The patient was a child, who is supposed to have produced the luxation while resting on the head with the feet in the air,—a practice very common among young lads. Suddenly the head became twisted to one side and fixed, severe pain and loss of power ensuing. The reduction was accomplished by fixing the body, making gradual traction of the head, and then turning the latter in a direction opposite to that of the deformity, when the symptoms of the dislocation immediately disappeared. Malgaigne gives two cases of a similar displacement, one of which was observed by his father and the other by M. Ehrlich; both having been restored by extension, counter-extension, and rotation. Whether these were really atlo-axoid dislocations, or dislocations lower down, it is impossible to determine.

TREATMENT.—As some uncertainty must necessarily attend the diagnosis of all such injuries, and as it is impossible to determine the complications which may exist, the greatest care will be necessary whenever an attempt is made to correct the supposed displacement. For an ill-advised movement

* London Medical Gazette, vol. iii.; Cooper's Surgical Dictionary.

† Edinburgh Medical and Surgical Journal, vol. xlii. p. 79, Cooper's Surg. Dictionary.

may inflict more serious damage to the cord than that occasioned by the injury itself.

That an effort at adjustment should be made admits of no discussion, as it is only by rectifying the evil that we can hope to save the patient's life. The clearest possible conception of the injury, however, should be obtained before any movements are made with a view to the reposition of the displaced vertebra.

Only general rules can be laid down to guide the surgeon in the reduction. The details applicable to particular cases must be left to his good sense.

1. The extension should be made in the line of the spinal column, and it should be exerted in a steady, gradual manner.

2. The counter-extension should be made from the shoulders: it is best applied by sheets passed over the shoulders, crossed in front and behind, and secured to the table upon which the patient lies. Or it may be made by the feet of the operator, planted against the summit of the shoulders, at the same time that he applies traction from the head with the hands. When the attempt to reduce is made with the patient in the sitting posture on the floor, the practitioner can fix the trunk by resting his knees on the shoulders of the patient.

3. Pressure and counter-pressure will materially assist in the work of replacement whenever a prominence denotive of the luxated piece can be discovered. The pressure should be applied over the salient body, and the counter-pressure against the stable part of the spinal column.

4. The head must be carried forward or backward, or rotated to one side or the other, according to the kind of dislocation.

If the attempts at reposition are crowned with success, the patient should be placed on a hard bed, with the head resting on a low, soft pillow and supported so as to prevent its falling to either side. The state of the bladder and of the bowels must not be overlooked.

Dislocations of the Dorsal Vertebrae.

The secure manner in which the dorsal vertebrae are locked together, the great strength of the intervertebral cartilages and ligaments, and the extent of their articulating surfaces, combine to render uncomplicated luxation of these bones a matter of great difficulty. Generally their displacement is associated with a fracture. This was the condition in most of the 13 cases collected by Malgaigne, the verity of which was established by dissection after death.

The vertebrae occupying the lower part of the dorsal region are those which suffer most, as the flexibility of the spine in this locality renders it more vulnerable than at any point below the neck. This is well illustrated by the fact that of the 13 dislocations alluded to above, 7 occurred between the ninth dorsal and the first lumbar vertebra.

The displacement may be FORWARD, BACKWARD, OR LATERAL.

These injuries are usually caused by extreme flexion of the spine, conjoined with the direct application of force.

The signs of the dislocation cannot be distinguished from those of fracture, being those of paralysis of the lower extremities, bladder, and rectum.

TREATMENT.—The chief indications are to provide for the vesical and rectal incontinence, and to prevent the occurrence of bed-sores.

At first it may be necessary to employ the catheter. But in a short time the urine will dribble away involuntarily. It should then be received into a urinal, or a bottle, so placed that the bed may be kept unsoiled. As, however, a certain amount of the urine—that in the most dependent part of the bladder—does not escape, catheterization will be required at least once in three days.

The evacuations can be received on a pledget of oakum.

The *water-bed*, when it can be procured, will be the best protection against bed-sores.

DISLOCATIONS OF THE BONES OF THE UPPER EXTREMITY.

Dislocations of the bones of the upper extremity may be divided into those of the *shoulder*, the *arm*, the *forearm*, and the *hand*.

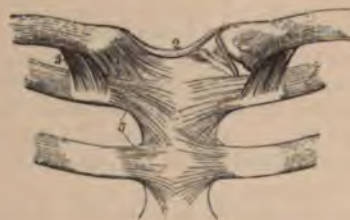
Dislocations of the Shoulder.

Dislocations of the shoulder include those of the *clavicle* and the *scapula*. The latter are often termed *dislocations of the clavicle at the acromial end*.

Dislocations of the Clavicle.—In 912 dislocations admitted into the Pennsylvania Hospital, 74 belonged to the clavicle, including, of course, those located at both ends of the bone. According to Flower, the relative frequency of these luxations is 3.10 per cent. Males are much more liable to this accident than females,—in about the proportion of four to one. The sterno-clavicular displacement, as compared with that of the scapula, is quite uncommon. In 50 cases observed by Hamilton, 41 were situated at the acromio-clavicular articulation, and only 9 at the sterno-clavicular. In 15 cases in which the location of the luxation is noticed in Alison's table,* 12 were at the sternal and 3 at the scapular extremity of the bone.

The clavicular articulation is formed between the end of the clavicle and the superior angle of the sternum. Between the two is an interarticular cartilage attached below to the first costal cartilage and to the clavicle above. The joint is surrounded by a capsular ligament, strengthened anteriorly and posteriorly by the anterior and posterior sterno-clavicular ligaments. Between the first costal cartilage and the under surface of the clavicle is the costo-clavicular or rhomboid ligament. And connecting the ends of the two bones is the interclavicular ligament. (Fig. 917.)

FIG. 917.



Sterno-clavicular, costo-clavicular, and inter-clavicular ligaments.

Dislocations of the clavicle (sterno-clavicular) may occur in three directions,—*forward*, *backward*, and *upward*. The displacement downward is prevented by the cartilage of the first rib, on which the bone rests.

Dislocation Forward.—The most frequent luxation is that *forward*; and this may be *complete* or *incomplete*.

In the complete variety the capsular, anterior and posterior sterno-clavicular, and rhomboid ligaments are torn. The interarticular cartilage may accompany the clavicle, or it may still adhere to the articular fossa. The end of the bone takes a position in front of and near to the upper extremity of the sternum. (Fig. 918.) In rare instances it has been seen considerably lower.

When the luxation is incomplete, the capsular ligament is only partially torn, together with some fibres of the anterior sterno-clavicular ligament.

CAUSES.—Any force of sufficient intensity acting on the outside of the shoulder (especially when it is drawn back), or against its anterior aspect, may cause this displacement.

SYMPTOMS.—The signs of a complete luxation are the presence of a hard swelling lying in front of the upper part of the sternum, immediately under the skin, a tense ridge, answering to the clavicular origin of the sterno-cleido-mastoid muscle, and with these a diminished space between the acro-

* Manuscript Table of Dislocations at the Pennsylvania Hospital.

mial process of the scapula and the sternum. (Fig. 919.) The movements of the arm are generally restricted, and cannot be made without pain being experienced at the seat of injury; and the head, as in fracture of the clavicle, is usually inclined towards the shoulder of the affected side.

FIG. 919.



Deformity following anterior luxation of the sternal end of the clavicle.

FIG. 918.



Position of the clavicle in anterior dislocation at the sternal extremity.

In the incomplete luxation the bone does not wholly leave its articulating cavity, inasmuch as the capsular ligament is only partially ruptured. The anterior prominence is, consequently, less marked than in the complete form of the injury, and is on a higher level than in the latter luxation.

TREATMENT.—Generally there is not much difficulty in reducing the luxation. This is most conveniently done by putting the patient on a stool or chair, and directing an assistant, after placing the knee between the scapulae, to draw the shoulders strongly backward, the surgeon at the same time pressing the displaced extremity into place.

If this method fails, a large woolen ball, or a pad fashioned out of any convenient material, should be placed in the axilla as a fulcrum. And while, with one hand, the surgeon, using the arm as a lever, grasps it at the elbow, pressing the latter to the side, and at the same time carrying the shoulder upward and backward, with the other hand he manipulates the bone into position. The difficulty, however, consists in *keeping* the bone in position,—a difficulty which thus far has proved insurmountable, in consequence of the weight and mobility of the shoulder and the shallowness of the articulating cavity on the sternum.

The *dressings* which have been employed for this purpose are the Desault and the Fox apparatus, used in the treatment of fractured clavicle; the adhesive plaster dressing, used for the treatment of the same injury; the posterior eight roller, and the Velpeau bandage. All appliances which draw the shoulders backward tend to force the sternal extremity of the clavicle against the anterior part of the ligament, and thus, unhappily, to facilitate rather than restrain the reproduction of the dislocation. All that can be hoped for is to maintain the bone approximately in position until such adhesions have been established as will give a certain degree of fixedness to its extremity. For this purpose the Velpeau dressing (Fig. 920)—allowing,

FIG. 920.



Velpeau dressing for luxation of the sternal end of the clavicle.

as it does, the shoulder to come forward, and at the same time securely immobilizing both it and the arm—will be found to possess advantages over most others.

Whatever apparatus is employed, it may become necessary to apply pressure directly over the sterno-clavicular articulation, by means of a thick compress secured with a roller. After the lapse of six or seven weeks the dressings may be laid aside and the arm supported in a sling for two weeks longer. By this time all that rest can accomplish will have been effected, when the use of the limb should be commenced. Notwithstanding that the natural relations of the bones are imperfectly restored, the usefulness of the arm is not seriously impaired.

Dislocation Backward.—This may be produced by force applied both in a direct and an indirect way. The force acts directly when it is applied to the anterior surface of the clavicle near the sternal extremity; indirectly when it is received upon the posterior and outer aspects of the shoulder, impelling the end of the bone through the posterior ligaments of the articulation.

This dislocation is less common than the one forward. The displaced end of the clavicle disappears in the neck; it is sometimes below and behind the top of the sternum; less frequently a little above it. The position of the bone beneath the sterno-hyoid and sterno-thyroid muscles, as alleged by Malgaigne, lacks confirmation.

SYMPTOMS.—The characteristic fullness of the sterno-clavicular articulation disappears, by the retreat of the sternal end of the clavicle backward into the neck, leaving in its place a depression, into which the finger can be introduced. The supra-sternal fossa is thus rendered less pronounced; the shoulder advances towards the median line; the head is inclined towards the sound side; and severe pain is experienced behind the sternum, particularly when the arm, which is also quite helpless, is moved. And, in cases where the displacement is great, there may be dyspnoea and difficult deglutition, in

consequence of the bone pressing against the trachea and the oesophagus. Even the great vessels at the root of the neck may be pressed upon, when there will be the signs of embarrassed circulation. Along with the rupture of the ligaments, some of the innermost fibres of the clavicular portion of the sternocleidomastoid muscle also may be torn.

TREATMENT.—The reduction is effected by standing behind the patient and drawing the shoulders upward and backward, when the bone will glide forward into its natural cavity. A posterior eight bandage (Fig. 921) will aid in retaining the parts in their place, the forearm being crossed upon the breast and supported in a broad sling.

This bandage can be rendered more effective by applying it over a thick roll-pledget placed between the shoulders.



Figure-of-eight dressing for a posterior dislocation of the sternal end of the clavicle.

Should this dressing prove unsatisfactory, the patient must be made to assume the horizontal position on a hard mattress, with the head resting on a low pillow, and with the arms crossed upon the chest,—a posture admirably adapted to preserve the reposition of the bone. Mr. De Morgan,

of the Middlesex Hospital, in a case of this luxation, succeeded in maintaining the reduction by a pad placed on the spine, over which was laid a splint extending across from one shoulder to the other and bound by the turns of a roller.* This plan may be adopted should the posterior eight bandage fail.

There is one instance of a posterior pathological dislocation of the clavicle recorded by Sir Astley Cooper, which was produced by the mal-direction of the bone consequent on a curvature of the spine, and in which the dyspnoea from pressure on the trachea was so great that, in order to save the life of the patient, Mr. Davie, of Bungay, was compelled to remove the sternal end of the bone.

Dislocation Upward.—This dislocation, the existence of which was for a long time denied, is now accepted as a well-established, though exceedingly rare, injury, there being only ten examples on record,—five collected by Maligne, two by Hamilton, and three by Bryant. One of those occurring in the practice of the last-named surgeon was remarkable for being a bilateral luxation, the sternal extremities of both clavicles being displaced upward, so that their ends could be brought together by pressing the shoulders towards each other. The third case referred to by Mr. Bryant is a specimen in Guy's Hospital Museum, London.

CAUSES.—This displacement is probably always produced by a force acting upon the top of the shoulder in such a way as to depress the acromial end of the bone and at the same time to force it inward.

SYMPTOMS.—The signs indicative of this luxation are a prominence above the top of the sternum (Fig. 922), a depression of the shoulder, partial obliteration of the supra-sternal fossa, and a tense state of the sternal origin of the sternocleido-mastoid muscle, which is stretched over the end of the displaced bone.

TREATMENT.—To restore the bone to its place requires that the shoulder shall be drawn *upward* and *outward*, while the head of the clavicle is pressed *downward* into its articular excavation. This is quite an easy task, the great difficulty being to retain it in position after reduction is effected. No contrivance has yet been devised capable of effecting this indication, and we are obliged, therefore, to be content with keeping the bone as nearly as possible *in situ*. A compress, laid over the part after reduction and fastened with a roller, will, when supplemented by the Fox apparatus, used for fracture of the clavicle, do all that bandages are capable of accomplishing.

FIG. 922.



Dislocation of the sternal end of the clavicle upwards.

Simultaneous Dislocation of both the Sternal and the Acromial End of the Clavicle.

This very unusual dislocation has been known to occur four times. Riche-rand† and Marel-Lavallée‡ have each reported one case. Dr. North,§ of Brooklyn, New York, has recorded a third, and Dr. Haynes,|| of Malvern Link, narrates a fourth. In the last instance, the acromial extremity was only subluxated. The reduction was accomplished in Dr. North's case by

* Holmes's System of Surgery, vol. ii. p. 805.

† Journal Hebdomadaire, vol. ii., 1831.

‡ Gazette des Hôpitaux, No. 33, 1859, Holmes.

§ New York Medical Record, April 16, 1866, Hamilton.

|| Hamilton on Fractures and Dislocations, 5th edit., p. 572, from British Medical Journal, Jan. 27, 1872.

as it does, the shoulder to come forward, and at the same time securely immobilizing both it and the arm—will be found to possess advantages over most others.

Whatever apparatus is employed, it may become necessary to apply pressure directly over the sterno-clavicular articulation, by means of a thick compress secured with a roller. After the lapse of six or seven weeks the dressings may be laid aside and the arm supported in a sling for two weeks longer. By this time all that rest can accomplish will have been effected, when the use of the limb should be commenced. Notwithstanding that the natural relations of the bones are imperfectly restored, the usefulness of the arm is not seriously impaired.

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FIG. 921.



Figure-of-eight dressing for a posterior dislocation of the sternal end of the clavicle.

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FIG. 922.



Dislocation of the sternal end of the clavicle upwards.

Simultaneous Dislocation of both the Sternal and the Acromial End of the Clavicle.

This very unusual dislocation has been known to occur four times. Riche-rand† and Marel-Lavallée‡ have each reported one case. Dr. North,§ of Brooklyn, New York, has recorded a third, and Dr. Haynes,|| of Malvern Link, narrates a fourth. In the last instance, the acromial extremity was only subluxated. The reduction was accomplished in Dr. North's case by

* Holmes's System of Surgery, vol. ii, p. 805.

† Journal Hebdomadaire, vol. ii, 1831.

‡ Gazette des Hôpitaux, No. 33, 1859, Holmes.

§ New York Medical Record, April 16, 1866, Hamilton.

|| Hamilton on Fractures and Dislocations, 5th edit., p. 572, from British Medical Journal, Jan. 27, 1872.

an assistant drawing the shoulders strongly backward, while the surgeon, with a thumb placed at either end of the bone, made pressure in such a manner as to correct the rotatory displacement produced by the muscles connected with the bone,—*i.e.*, by pressing the sternal end backward and upward and the acromial end backward and downward.

The *dressing* which would answer in a luxation of this nature would be (after carrying the shoulders back and fixing them in that position by a posterior eight roller) a compress placed over the sternal end of the clavicle and fastened by a figure-of-eight bandage, and a second compress, applied to the acromial extremity and secured by a spica of the shoulder.

The results obtained in the treatment of the recorded cases of this accident are better than would, theoretically, have been anticipated.

DISLOCATIONS OF THE SCAPULA.

Dislocations of the scapula, commonly designated *dislocations of the acromial extremity of the clavicle*, are more common than those which occur at the sterno-clavicular articulation. There are three varieties of this luxation,—one, in which the acromion process is carried beneath the clavicle (Fig. 923);

FIG. 924.

FIG. 923.



Dislocation of the scapula beneath the clavicle.



Deformity in downward dislocation of the scapula.

a second, in which the process is forced above the clavicle (Fig. 927); and a third, in which both the acromion and coracoid processes are placed above the clavicle. The first is the most common.

The acromio-clavicular articulation is quite movable. The joint consists in a shallow depression on the acromion adapted to a slight rotundity at the outer end of the clavicle, and surrounded by a capsular ligament.

CAUSES.—The displacements are caused by a fall or by a stroke from some body, acting upon either the clavicle or the acromion process of the scapula. They have also been produced by the arm being suddenly drawn forward over the head; and by a force acting against the collar-bone from below.

Whether the acromion process is placed above or below the collar bone, the shoulder, losing the support of the clavicle, sinks downward and forward.

Dislocation Downward.—**SYMPTOMS.**—In the first and most common form,—that in which the displacement is downward,—a hard prominence, made by the acromial end of the clavicle, can be seen and felt at the *summit of the shoulder*, covered by the integument. There it is held between the antagon-

izing fibres of the trapezius and the deltoid, the former muscle being at its inner margin unnaturally prominent. (Fig. 924.)

The arm, though disabled, and only raised with difficulty, is not rendered altogether helpless. It is restricted in its movements more from the injury to the deltoid muscle caused by the determining violence, and from the pain which is experienced, than from any mechanical disadvantage attending the accident.

TREATMENT.—The reduction is readily accomplished by seating the patient on a stool, and then, raising the shoulder upward and outward, grasping the elbow with one hand, while with the other hand the clavicle is depressed.

Another plan is to plant the knee between the shoulders, and draw them upward and backward, until the bone returns to its proper position.

After the adjustment, a compress must be placed over the acromio-clavicular articulation, and the arm confined with a Velpeau roller dressing, or a spica of the shoulder. (Fig. 925.)

The reduction is rarely ever permanently retained, there being always a latitude of movement between the bones much greater than normal. But this does not appear to weaken the arm materially.



Spica dressing for downward dislocation of the scapula.

Dislocation Upward.—For a long time the possibility of this luxation was denied, but it has come to be recognized as a veritable displacement. Three instances of the dislocation have been observed; and although only one was verified by a post-mortem examination, yet in one of the others the recorded symptoms of the injury seem to be so complete as to leave little doubt that it was really of the nature described. The only thing which militates against the acceptance of the third is the statement that the luxation was complete without a visible trace of the injury. These cases have been collected by Malgaigne.

The relation of the bones in this luxation is such that the clavicle is placed beneath the acromion,—between it and the coracoid process; and in M. Tournel's case it extended so far towards the supra-sternal fossa as to be felt on the outer side of the acromion.

CAUSE.—To place the clavicle in so improbable a situation would necessitate the application of a severe force at its acromial extremity, with simultaneous counter-pressure made on the outer and anterior surface of the shoulder, and in a direction also by which the latter would be forced backward and upward.

SYMPTOMS.—In this upward displacement, the acromion process should appear abnormally prominent, and a considerable sulcus should be felt along its inner border. The space between the shoulder and the sternum will be lessened, the ability to raise the arm diminished, and the whole contour of the parts changed. (Fig. 926.)

TREATMENT.—The same manipulation which is employed to reduce the downward luxation of the scapula will be proper for the correction of the displacement upward; namely, planting the knee between the shoulders and drawing them upward and backward until the bones resume their natural relations. Then the endeavor should be made to preserve them in place by means of a Velpeau or a Fox dressing,—a task which will be found difficult of execution, and promising no better results than in the former dislocation.

In two of the cases recorded the dislocations were never reduced. Notwithstanding the unsatisfactory nature of the reduction, it appears from the history of the cases referred to that the usefulness of the arm was but little impaired.

FIG. 926.



Deformity in upward dislocation of the scapula.

FIG. 927.



Dislocation of the scapula above the clavicle.

THE SECOND VARIETY OF THE UPWARD DISLOCATION is one in which the clavicle is placed beneath the coracoid process of the scapula. This dislocation was first described by Godemer* about the year 1843. This writer published 5 cases of the injury, which, with one noticed by Pinjou,† constitute all the examples of this accident that have been recorded up to the present time.

CAUSES.—This displacement could not occur without the operation of two forces,—the one forcing the shoulder upward, outward, and backward, and the other driving the acromial end of the clavicle downward.

SYMPTOMS.—There will be a striking depression along the inner side of the acromion; an unusual prominence of the latter process and of the coracoid; a hard ridge formed by the shoulder, extending obliquely downward towards the axilla; pain and restricted inward movements of the arm; and an increase of distance between the sternum and the summit of the shoulder.

TREATMENT.—The arm being flexed and brought to the side by an assistant, in order to relax the clavicular portion of the pectoralis major muscle, it should next be carried forcibly upward, outward, and backward, while the surgeon, grasping the clavicle and disengaging it from beneath the coracoid process, presses it into its proper site.

Dislocation of the Inferior Angle of the Scapula.

The latissimus dorsi muscle, where it passes over the lower angle of the scapula, is occasionally displaced, so as to slip beneath this extremity of the bone. The accident sometimes occurs to children as a result of lifting them by one arm over street-gutters.

The displacement may be recognized by the projection of the lower angle of the scapula, which is increased when the arm is drawn forward; by the resistance encountered in the same movement; and sometimes by the pain experienced in the region of the injury. Though I have seen what I be-

* Godemer, Recueil des Travaux de la Société Médicale d'Indre-et-Loire, 1843. From Vidal.

† Pinjou, Jour. de Méd. de Lyon, Juillet, 1842. From Vidal, Hamilton.

lieved to be this displacement in two instances, still, I think it may be deemed an uncommon accident.

To *correct* the disarrangement, it is advised to relax the muscle as much as possible, by carrying the arm well back, and, while it is thus situated, to hook the muscle into position with the fingers.

In the cases to which reference is made, my efforts at reduction were entirely unavailing.

DISLOCATIONS OF THE HUMERUS.

The great variety and extent of movement allowed by the scapulo-humeral articulation are due to the shallowness of the glenoid cavity of the scapula, to the extensive hemispherical surface of the head of the humerus, and to the magnitude of the capsular ligament. The chief protection to the joint consists in what may be called the *extra-capsular* cavity, in which the head of the bone moves, and which is formed by the acromion and coracoid processes with their connecting ligament.

Frequency.—While these peculiarities of organization, as regards the mobility of the scapula, enlarge very much the range and variety of the movements which the upper extremity is capable of executing, they nevertheless render the articulation less secure; and hence dislocations of the humerus exceed in frequency those of all other joints combined. In 912 luxations treated at the Pennsylvania Hospital, 458 belonged to the scapulo-humeral joint. Of this number, 218 occurred between twenty-five and forty-five years of age. After sixty-five the number rapidly diminishes. Malgaigne found that out of 491 dislocations, 321 were of the shoulder. Seven cases under fifteen years are noted. A few instances of this luxation have been observed at a much earlier period of life. Dr. John Ashhurst mentions one which he saw at two years; Dr. Packard records another at the same age; and one has been noticed by Flower and Hulke, admitted into the Middlesex Hospital, in a child fourteen days old.

Males, as might be expected from the nature of their occupations, suffer more than females; that is, in about the proportion of seven of the former to one of the latter.

Varieties.—The numerous varieties of this luxation which have been described by different writers I have no disposition to question. They have, undoubtedly, a certain amount of interest in the direction of pathological exactitude; but practically, in all that concerns the recognition and treatment of this luxation, they are valueless.

There are *three primary* dislocations of the humerus. First, there is the dislocation *downward and slightly inward*, or *subglenoid*, sometimes termed *axillary*; second, *forward*,—with two varieties, the *subcoracoid* and the *subclavicular*; third, *backward* on the dorsum of the scapula, or *subspinous*.

The last-named luxation is comparatively rare, there being only about thirty cases on record. The most common variety is that in which the humerus is displaced *forward*, or the *subcoracoid* luxation.

DISLOCATION DOWNWARD (Subglenoid).—In this luxation the capsular ligament is extensively torn at its lower surface, and the head of the humerus, slipping through, takes its position on the anterior border of the scapula, immediately *below the glenoid cavity*. (Fig. 928.) Or it may be a little higher towards the subscapular surface of the neck of the bone, close to its articulating cavity. In either case it is situated between the tendons of the triceps extensor cubiti and subscapular muscles. In two specimens of old unreduced luxations in my possession, such are the positions of the head of the humerus; and there they have formed for themselves imperfect articular cavities.

The axillary blood-vessels and nerves suffer more or less from pressure, the deltoid being in some instances paralyzed from the damage done to the circumflex nerve. The muscles which surround the articulation are variously

affected. The deltoid muscle and the muscles on the dorsum of the scapula, the supra-spinatus and infra-spinatus, are put upon the stretch, especially the first two. The same is true, but in a

FIG. 928.



Subglenoid luxation.

less degree, of the subscapularis and the coraco-brachialis, both of which muscles may be partially torn. Even the greater tuberosity of the humerus may be detached. The long tendon of the biceps may be dragged out of its groove. And, as the humerus is below the articulating cavity of the scapula, and, therefore, nearer to the origin of the teres major and teres minor muscles, these muscles are slightly relaxed.

CAUSES.—This luxation is liable to occur in a variety of ways. It may follow a fall upon the anterior surface of the shoulder. A blow on the same part, when the arm is in the extended position, may readily produce the displacement; and it may also be caused by a force which drags the arm over the head. In three instances I have seen the dislocation produced by muscular contraction while patients were writhing in a paroxysm of epilepsy.

The muscles of the scapula sometimes become so relaxed, from constitutional weakness or from paralysis, as to allow a dislocation of the humerus to take place without any laceration of the capsular ligament.

FORWARD DISLOCATION.—There are two forms of the forward dislocation, —the *subcoracoid* and the *subclavicular*.

In the *subcoracoid* form, the capsular ligament is lacerated on its anterior aspect, and the head of the bone, passing through, assumes a position on the inner surface of the neck of the scapula, below the coracoid process. (Fig. 929.) This luxation is the most common. Occasionally the head of the humerus is found farther back upon the subscapular fossa, beneath the subscapular muscle. This displacement was perhaps first noticed by Sir Astley Cooper. It has also been described by Velpeau and by Malgaigne, the former designating it a subscapular and the latter a subcoracoid luxation. Dr. Wood* and Dr. Parker,† of New York, have also each given an example of this dislocation. The subcoracoid luxation may, secondarily, be produced either by the spasmodic contraction of the clavicular part of the great pectoral and coraco-brachial muscles, or by manipulations converting the downward or subglenoid variety into the former.

The second form of the forward dislocation is the *subclavicular*, in which the head of the bone rests on the side of the chest, below the clavicle. (Fig. 930.) This displacement answers to the intra-coracoid of Nélaton.

When the head of the bone thus rests on the side of the chest below the clavicle, it is covered by the pectoralis major and minor muscles. The supra-spinatus and infra-spinatus muscles, and those portions of the deltoid which arise from the acromion process and from the spine of the scapula, together with the inner fibres of the coraco-brachial muscle, and the short head and long tendon of the biceps, are all put upon the stretch. The subscapularis is carried upward in the direction of the displacement. The axillary vessels and plexus of nerves are subjected to severe pressure. Laceration of the supra-spinatus and infra-spinatus muscles may occur; or, if they are strong enough to resist the disturbing force, the tubercles upon which their tendons are attached may be detached from the bone. In rare instances, the tendon

* New York Journal of Medicine, May, 1850, p. 282, Hamilton.

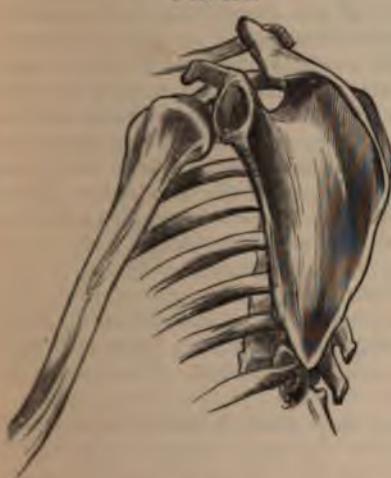
† Cooper's Surgical Dictionary, by Recse.

of the subscapularis has been torn away from its connection with the lesser tuberosity.

CAUSES.—Any force which carries the forearm violently backward and

FIG. 930.

FIG. 929.



Subcoracoid luxation.



Subclavicular luxation.

upward, by pressing the head of the humerus against the inner part of the capsular ligament, may cause forward (subcoracoid) luxation. It is often produced by blows or falls upon the outer surface of the shoulder. When the violence is sudden and intense, the head of the bone may be carried beyond the innermost limits of the coracoid process, and it may assume the subclavicular position. In a case given by Colles, the force was sufficient to fracture the coracoid process.*

BACKWARD OR SUBSPINOUS DISLOCATION.—In this luxation the head of the bone occupies the dorsum of the scapula, posterior to the glenoid cavity and immediately below the spine. (Fig. 931.)

The effects on the scapular muscles will be to render them tense, or to tear the subscapularis and supra-spinatus; to relax the infraspinatus and the teres minor; and to stretch the long tendon of the biceps and the clavicular part of the deltoid.

Malgaigne has described two luxations on the dorsum of the scapula,—the subacromial and the subspinous,—a distinction possessing no value, as it only serves to express a very trifling difference in the position of the head of the bone.

CAUSE.—Luxations backward are produced by force applied to the anterior surface of the shoulder, possibly by any cause dragging the forearm forward.

PARTIAL LUXATIONS, OR SUBLUXATIONS.—A form of incomplete dislocation of the humerus has been described by Sir Astley Cooper and by Malgaigne. The existence of this injury has been predicated upon the presence of a depression beneath the acromion, upon the posterior aspect of the joint, and upon a well-rounded

FIG. 931.



Subspinous luxation.

* Dublin Quarterly Journal, 1855, vol. xx.

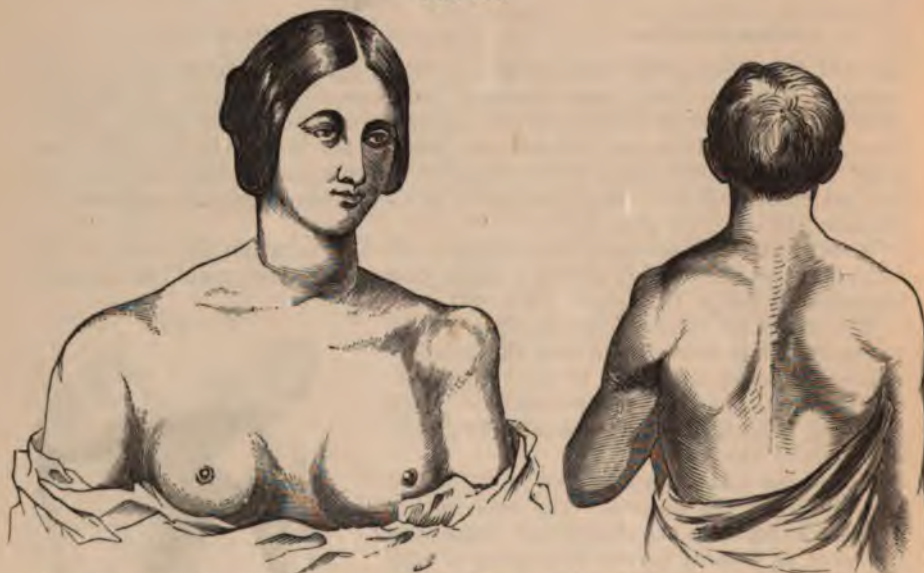
prominence formed by the head of the humerus lying in contact with the coracoid process. To the anatomist such a dislocation, independent of a fracture of the coracoid process, will appear impossible; and, as this luxation has never been verified by dissection, there is no sufficient reason for assigning it a place within the domain of surgical pathology. Mr. Soden* attributes the unusual position of the head of the humerus in these cases of so-called *partial* luxation to rupture of the long tendon of the biceps muscle, in consequence of which the supra-spinatus draws the bone out of its normal place.

I have in at least three instances seen the condition present which is said to characterize this supposed displacement; and, from the nature of the precedent injuries, I have been disposed to refer the anterior fullness on the inner aspect of the joint to a loss of power in the posterior scapular muscles, in consequence of which the head of the humerus is drawn unusually inward by the subscapularis, and inward and upward by the clavicular fibres of the pectoralis major and deltoid muscles; and likewise, though in a less degree, by the coraco-brachial and the short tendon of the biceps.

Partial displacement may be produced by chronic articular arthritis, as has been pointed out by Dr. Adams. I have before me a specimen in which the luxation (subcoracoid) is complete from this cause. The glenoid cavity and the parts contiguous are studded with irregular nodules of bone, and the surface of the head of the humerus is completely eburnated. The tendon of the biceps, in this case, has been destroyed.

A backward partial dislocation, however, may occur without rupture of

FIG. 932.



Loss of rotundity of the shoulder and concavity beneath the acromion in subglenoid and subcoracoid luxations. a, front view; b, posterior view.

the capsular ligament, the head of the bone resting upon the posterior lip of the glenoid cavity.

Common Signs of Scapulo-Humeral Dislocations.—There are certain signs which are common to all varieties of dislocation of the humerus. There is first a marked alteration in the external contour of the shoulder, which, in persons somewhat lean, is very striking indeed. The rotundity of the shoulder disappears. It becomes flattened, and instead of the natural softness of the parts, they have a tense feel. The acromion process is abnor-

* London Medical Gazette, July, 1841.

mally salient or prominent, being sharply defined both to the eye and to the touch. Beneath the acromion is a depression into which the finger can be readily sunk (Fig. 932), and which is rendered still more perceptible when the arm is raised from the body. In consequence of the traction made on the deltoid muscle, the elbow stands off from the body, with a single exception, viz., in *subspinous luxation*. Nor can the hand of the injured limb, if the limb is pressed to the side, be placed upon the shoulder of the sound side.

The arm is fixed and constrained in all its movements. A round, resisting body—the head of the humerus—can be felt in its abnormal position. In the subglenoid and subcoracoid forms, this prominence will be discovered in the axilla, and will become more marked when the limb is carried off from the side. It can be identified as the head of the humerus if, on placing upon it the fingers of one hand, it is found to move with the rotation of the arm.

In the subcoracoid luxation the prominence of the head of the humerus will be found immediately below the coracoid process. (Fig. 933.) In the subclavicular variety it will be found below the clavicle. (Fig. 934.) And in the subspinous luxation it will be detected below the spine of the scapula. (Fig. 935.)

FIG. 933.



Subcoracoid luxation.

FIG. 934.



Subclavicular luxation.

FIG. 935.



Subspinous luxation.

Pain is felt extending down the arm, and often accompanied by numbness of the fingers, in consequence of pressure on the axillary plexus of nerves. And, lastly, there is a loss of from one to two inches in the vertical circumference of the shoulder-joint of the injured side. This last-named sign can be determined by the plan first pointed out by Mr. Callaway,* viz., measuring with a tape-line over the acromion and through the axilla. This test is,

* Callaway upon Dislocations and Fractures of the Clavicle and Shoulder-Joint.

however, not reliable after the traumatic swelling sets in, in which case the measurement may greatly exceed that of the sound shoulder.

The variations which are found to exist between the different forms of scapulo-humeral dislocations will best appear by placing them in contrast, as below :

DISLOCATION DOWNWARD. (<i>Subglenoid.</i>)	FORWARD. (<i>Subcoracoid.</i>)	BACKWARD. (<i>Subspinous.</i>)
Shoulder extremely flattened.	Flattened, but not extremely so.	Moderately flattened.
Acromion very prominent.	Prominent.	Moderately prominent.
Depression below the entire arch of the acromion.	Greatest at the posterior part.	Greatest at the anterior part.
Elbow projecting from the side of the body.	Projecting from side of the body.	Elbow to the side of the body and arm advanced.
Axis of humerus directed below the glenoid cavity.	Direction anterior to and below glenoid cavity.	Directed posterior to the glenoid cavity.
Inability to place the hand of the injured side on the sound shoulder.	Inability to place the hand of the injured side on the sound shoulder.	Ability to place the hand of the injured side on the sound shoulder.
Presence of a hard hemispherical tumor in the axilla.	Presence of a hard hemispherical tumor in the axilla, but higher.	Absence of a hard tumor in the axilla, but one present below the spine of the scapula.
Pain and numbness in the arm and fingers.	Pain and numbness in the arm and fingers <i>very marked</i> .	Much pain in the shoulder, little in the arm, and no numbness of the fingers.

Subclavicular Form.

The acromion most prominent of *all* the luxations. A round hard tumor below the clavicle. Elbow directed *backward*.

DIAGNOSIS.—Notwithstanding that the signs of scapulo-humeral dislocation are usually very striking and clear, the accident is frequently overlooked. Every year I see a number of such cases. Errors of this kind ought not to occur if the patient is seen shortly after the injury befalls him. But when some time has elapsed before the practitioner is called in, and when considerable swelling exists, measurably effacing the prominences and the flattening which commonly form such characteristic features of the displacement, the mistake may easily be committed. The injuries with which this dislocation may be confounded are contusions, fracture through the neck of the scapula, fracture near the head of the humerus, and fracture of the acromion process.

With a view to render the examination thorough, when any doubt as to the nature of the injury exists, the patient should be placed under the influence of an anæsthetic. If the different movements of the arm can be made by the surgeon with freedom, and on raising the arm above the level of the shoulder the finger cannot be thrust into a space beneath the acromion, and if the head of the humerus cannot be felt in the axilla on the front of the chest nor below the spine of the scapula, and if, also, the arm can be placed, without an effort, vertically along the side of the body, the elbow not projecting outward, forward, or backward, the idea of luxation may be confidently dismissed.

In fracture of the neck of the humerus, of the neck of the scapula, or of the acromion, there will be preternatural mobility, rude crepitation, and a readiness of reduction, with a tendency to the recurrence of the deformity as soon as the limb is released from the manipulating force. The prominence of the upper end of the lower fragment, which is sometimes felt through the pectoral muscles, in a fracture of the surgical neck of the bone, can be readily distinguished from the smooth, hemispherical head of the humerus by its irregular, spiculated form. Even in separation of the epiphysis, the diaphysis, though not presenting spiculæ, has a plain, flat surface, instead of a round one like the head of the humerus. This circumstance, taken in con-

nection with the fact that epiphyseal fractures occur at a period of life when dislocations are uncommon, would leave little room for error.

I have purposely omitted any reference to the occupation or non-occupation of the glenoid cavity of the scapula by the head of the humerus, and also to the presence or absence of flattening of the shoulder, as there are contusions of the muscles about the articulation, which, by permitting the head of the bone to drop, may create a considerable vacancy beneath the acromion, simulating the condition presented in luxation. And, on the other hand, the inflammatory transudation may readily restore the normal rotundity to the shoulder.

TREATMENT.—There are two methods practiced for the restoration of a dislocated humerus,—the one by *manipulation*, and the other by *extension and counter-extension*.

Reduction by manipulation.—This plan, in its application to dislocations of the shoulder, has been reduced to a system by Professor H. H. Smith, of Philadelphia. Fig. 936 represents the various positions of the limb during the different stages of reduction by this method. It consists in simply placing the limb in such a posture that those muscles connected with the upper extremity of the humerus, and which are rendered tense by the displacement, shall be relaxed, and the head of the bone lifted or rolled into place.

From a number of studies which I made some years ago upon the cadaver, on the mechanism of this luxation and its reduction, I am led to believe that the coraco-humeral part of the capsular ligament remains *untorn*, and that it performs an important office in conducting the head of the bone into the glenoid cavity, during properly applied efforts at reposition.

In the subglenoid dislocation, the muscles which are placed upon the stretch, and which, consequently, fix the bone in its unnatural position against the elevated lip of the glenoid cavity, are the supra-spinatus and the deltoid. In the subcoracoid and subclaviar forms of the forward luxation, in addition to the supra-spinatus and deltoid, the infra-spinatus and teres minor muscles are put upon the stretch. And in the posterior or subspinous displacement, the subscapularis, teres major, pectoralis major, and supra-spinatus muscles are rendered tense. In all the varieties of the luxation the long tendon of the biceps is on the stretch.

Keeping these facts distinctly before the mind, the surgeon, understanding the origin and insertion of the scapulo-humeral and thoraco-humeral muscles, will have little difficulty in directing the arm in such a manner as to remove all resistance, and to bring its movement entirely under his will.

In the demonstration of the method by manipulation, let us take, for example, a case of subglenoid luxation. The patient, having been placed in the recumbent position on a bed or a table, should be etherized. The first indication is to remove the strain from the long head of the biceps, and to relax the deltoid and supra-spinatus muscles. This is accomplished by flexing the forearm upon the arm, grasping the latter at the elbow and raising it upward along the side of the head by abduction, and then supinating the forearm. While it is in this position, let the surgeon place two or three fingers of the other hand upon the head of the humerus, which will appear under the skin of the axilla. (Fig. 937.) And as the arm is drawn out-

FIG. 936.



Elevation, abduction, and adduction of the arm, with supination of the forearm, in restoring a subglenoid dislocation.

ward, and is brought to a right angle with the chest, let the head of the bone at the same time be lifted into its socket.

FIG. 937.



Reduction by manipulation as practiced by author.

with the side of the face and the head; and, third, *outward*, at a right angle with the body.

FIG. 938.



Reduction with the heel in the axilla.

out boot or shoe, against the axilla of the patient, there being interposed a folded towel to protect the skin. (Fig. 938.)

A steady, continuous, and gradually-increasing extension is now made for a minute or two by pulling upon the towel, when the bone ordinarily slips into its socket with a sound which can often be distinctly heard. I have found, when using this plan, that after making extension for a short time

When the dislocation is forward, either subcoracoid or subclavicular, the arm, after being elevated, should be rotated *externally* before being carried down, in order to relax still further the supra-spinatus, infra-spinatus, and teres minor muscles, or such of them as may not be torn. Professor Smith directs that the rotation be made before the elevation of the arm, or abduction; but I find that it is more easily and thoroughly done after the strain on the external capsular muscles has been lessened.

When the dislocation is backward, the arm, after being carried to extreme abduction, must be rotated inward, to relax the subscapular muscle, and the head of the bone be pushed forward with the thumb and fingers during the movement of adduction.

Extension and counter-extension.—In reduction by extension and counter-extension, the arm may be placed in three positions: first, *downward*, parallel with the body; second, *upward*, parallel

First position.—The simplest way of using the former method is that employed by Sir Astley Cooper. The patient is placed upon a low bed, table, or settee, in a horizontal position. A jack-towel or a sheet is next to be secured to the arm a short distance above the elbow-joint, and the forearm is to be flexed at a right angle with the arm. The surgeon, taking his seat upon the bed, with one foot resting on the floor, plants the other, with-

the reduction was facilitated by carrying the arm somewhat across the body, as, by so doing, the side of the surgeon's unbooted foot becomes a fulcrum against which the bone is pried outward towards its articulating cavity.

When greater force becomes necessary, the extension may be increased by one or more assistants taking hold of the band; and the exhibition of an anæsthetic should not be omitted.

Second position.—Reduction with the arm in the second position,—i.e., *parallel with the side of the head and face*,—commonly called the method of La Mothe (Fig. 931), is more easily accomplished than by any other method in which extension and counter-extension are employed. It is the one to which I always give the preference when manipulation fails, and when also the luxation is not an old one.

The danger to the blood-vessels when these, by inflammatory changes, have become glued to the head of the bone, is certainly greater, if much force is applied in this position of the arm, than is incurred in any other method. It was while attempting to reduce an old and obstinate dislocation of the humerus by this plan of La Mothe that I once ruptured the axillary vein; and, although the patient did not perish, yet for some days she was in a very critical state.

The advantage of this method in recent luxations will, however, be obvious to any one who will recall the anatomical relations of the parts. For it insures most effectually the relaxation of those muscles which detain the dislocated bone in its unnatural position, viz., the supra-spinatus and the deltoid.

To apply the reductive force by this plan, the patient should be placed in the recumbent position on a table, or obliquely across a bed. The surgeon, taking hold of the limb of the injured side above the elbow with one hand, and planting the other on the top of the shoulder (Fig. 939), in order to fix the scapula, makes strong traction on the arm. The bone will frequently slip into its socket on the slightest extension being made. But if it resists, let

the limb, while the traction is still maintained, be rotated and carried a little off from the body, counter-pressure being made by the foot placed upon the shoulder. (Fig. 940.) And as it is being returned to the natural position by the side, the surgeon will generally be rewarded by feeling the head of the bone return to the glenoid cavity.

If still foiled in effecting the reposition, an advantage may be gained by securing the aid of an assistant, who shall press the head of the bone upward and outward towards the articulating cavity, while the arm, still strongly extended as before, is being brought down to the side.

Third position.—The patient being placed on a bed as in the other methods, the arm is to be carried to a *right angle with the body*. The surgeon now grasps the arm above the elbow, and, planting his foot across the posterior fold of the axilla, so as to fix the scapula, he begins to make extension. (Fig. 941.) As soon as the muscles are found to yield, the arm must be directed towards the side, with a view to guiding the bone into its socket.

The late Professor N. R. Smith, of Baltimore, occasionally adopted a plan which was originated by his father, Nathan Smith, of New Haven, for fixing

FIG. 939.



La Mothe's mode of reducing a luxated humerus. Scapula fixed by the hand.

the scapula during the efforts made for restoring a dislocated humerus while the limb is at a right angle with the body. The plan was this. The patient

FIG. 940.



Scapula fixed by the foot.

FIG. 941.



Reduction with the arm at a right angle with the body.

having been seated on a chair, a band was passed through the axilla, and one of its ends carried across the chest, the other across the back, and continued along the anterior and posterior aspects of the sound arm, to the wrist of which they were secured by a circular band. Another band was then attached to the wrist of the injured arm; and still another was passed over the top of the shoulder, and brought down front and back and tied fast under the chair. By now making counter-extension from the sound arm, while extension was simultaneously made from the injured one, the scapulæ, through the trapezii muscles, were fixed. While these forces were being exerted at the wrists of the extended arms by the assistants, the surgeon, with his foot resting upon the chair, pressed his knee into the axilla of the patient, thus lifting the bone into its place. (Fig. 942.)

Sir Astley Cooper was in the habit of restoring luxations of the humerus by placing a foot on the chair occupied by the patient and, with one hand on the top of the shoulder and the other hand grasping the arm, bending the limb forcibly over the knee planted in the axilla. (Fig. 943.)

If it should be deemed necessary to employ still greater force than that attainable by the measures already described, recourse can be made to the compound pulley, counter-extension being used, and the scapula being fixed by a strong band, slit in its centre and slipped over the arm to the axilla, after the plan of Sir Astley Cooper. (Fig. 944.)

Except in cases where surgical assistance is early at hand, an anæsthetic should always be administered before any attempt at reduction is made.

By whatever means a dislocation of the shoulder is restored, it is necessary afterwards, to prevent a recurrence of the displacement, that the arm should be secured to the body for two weeks. The best means of doing this is a Velpeau bandage.

After its removal, the arm should be carried for two weeks in a sling, and during this time movements should frequently be practiced, with a view to establishing the function of the joint.

If much pain and swelling follow the accident, the application of leeches about the joint will aid in obviating future stiffness in the movements of the shoulder. Keeping the articulation enveloped in a lotion of laudanum and water will also contribute much to the comfort of the patient.

FIG. 942.



N. Smith's method of reduction.

Professor Kocher adopts a method for the reduction of subcoracoid luxations, which was tested in the Chambers Street Hospital, New York, by the direction of Dr. Bull. Of 126 cases so treated 98 were successful. The object in this plan of operation is to open the rent in the capsular ligament,

FIG. 943.



Sir Astley Cooper's plan of reduction over the knee.

FIG. 944.



Pulley extension.

and relax the untorn portion independent of force. The execution of the method consists in four movements:

1st. The arm, flexed to a right angle, is brought close to the side of the body, while the surgeon grasps the wrist with one hand and the elbow with the other.

2d. The arm is drawn down and strongly rotated outwards, and then held for a short time.

3d. While thus rotated, the arm is carried forward and upward on the chest.

4th. The hand is carried upward and placed on the sound shoulder.

The above method is not adapted to the subglenoid dislocation, but may be employed in cases where the head of the bone is within the coracoid, also the subclavicular, observing, however, in the latter variety, to bring the elbow some distance behind the axillary line.

Complications.

Old Unreduced Luxations of the Humerus.—How to deal with cases of this kind is often a very perplexing question. The resistance encountered is not always in exact ratio with the duration of the dislocation. I have in several instances experienced more difficulty in replacing a luxated humerus of three weeks' standing than with one which had remained unreduced for three months. Yet, as a rule, the more ancient the dislocation the greater will be the obstacles to its reposition.

If the bone has been out of place for months, and is moderately movable in its new position; if, following the injury, there was a history of severe inflammation, uniting most probably the blood-vessels and also the axillary plexus of nerves to the head of the bone; and if, in addition, there is no severe pain experienced in the limited use of the arm still possible, the surgeon will do well not to urge reduction. If, however, the patient suffers severe pain, rendering the limb quite helpless, and if he insists on an effort being made to replace the bone, after a full understanding of the dangers incurred, the surgeon will be justifiable in making the attempt, never, however, presuming to transcend what, in his own judgment, is the limit of safety in the use of the measures which he may employ for the purpose of reduction.

In the management of a case of this kind, after the etherization of the patient, the first thing to be done is to separate the head of the bone from its surrounding attachments. This is best done by gentle but gradually-increasing rotation. When the detachment has been accomplished (which may be reasonably conjectured by the increased freedom with which the bone moves), an attempt may be made to replace it by manipulation. Should manipulation fail, a resort may be had to the pulley, or to some of the different appliances for extension which have been described. Often it will be found advantageous *not* to employ these forcible plans of extension at first, but to be content for the first few days with repeated efforts at breaking up adhesions, so that less resistance may be encountered and less danger to the vessels incurred should it eventually prove necessary to employ extraordinary force. Should these measures fail, there remains the operation of Dr. Mears, that of dividing, by means of an Adams saw, subcutaneously, the surgical neck of the humerus, and establishing a false joint. The accidents which may occur during the employment of forcible measures at reduction are laceration of the muscles, rupture of blood-vessels, and injury to nerves. A curious instance of the first-named accident occurred at St. Bartholomew's Hospital,* during an attempt to restore a dislocated humerus of eight weeks' standing, in which the pectoral muscles were torn and the axilla laid open, although no force was used other than that exerted by the hands of a house-surgeon pulling on the arm and having his unbooted foot in the axilla. The muscles, in this case, were in a state of degeneration.

Rupture of the Axillary Artery.—Dr. Willard, in an excellent paper† on rupture of the axillary artery and vein, has collected 19 cases of this accident, 12 of which proved fatal, 6 recovered, and 1 was not determined. The symptoms which indicate this lesion are a sudden swelling in the axilla and under the pectoral muscles, absence of the pulse at the wrist, pallor of the face, and, in some instances, syncope. When the opening in the vessel is small, or when the laceration does not extend through all its coats, the accident may not be immediately detected; it being only recognized when the accumulation of blood or the dilatation of the weakened vessel has attained considerable magnitude and has assumed the characteristics of an aneurism. It is from this circumstance that even surgeons of eminence have been led into errors of diagnosis which have been followed by fatal consequences. Thus, Dupuytren opened a swelling which appeared in the axilla of a woman two months after the reduction of a dislocated shoulder, supposing it to be an abscess.

* Lancet, July 6, 1878.

† Philadelphia Medical Times, August 16, 1873.

The patient perished from hemorrhage. A similar mistake was committed by Pelletan. *Auscultation* of the tumors would have prevented both of these catastrophes.

TREATMENT.—Upon the occurrence of a sudden axillary or pectoral swelling, pressure should be instantly made over the subclavian artery until the nature of the tumor is clearly revealed. And if it is ascertained to arise from a rupture of the axillary artery, there remains either the ligature of that vessel above and below the laceration, or the ligature of the subclavian artery. Blackman, Callender, and Lister, after such an accident, have each tied the axillary artery. Notwithstanding, the patients all died. In Callender's case, gangrene of the limb followed, though the immediate cause of death seems to have been some pulmonary complication. Mr. R. Adams has recorded a case of recovery after ligature of the axillary artery above and below the point of rupture.

Gibson, Nélaton, Warren,* and Adams each tied the subclavian artery. The cases of Warren and Adams proved successful; that of Gibson, fatal; and in that of Nélaton the result is not stated. In Warren's case the laceration of the vessel was caused by the boot of the surgeon while making counter-extension.

When it has been once determined that the axillary artery has been torn, the axillary space should be freely laid open, the blood-clots turned out, and a ligature applied both above and below the lesion in the vessel. This course would seem preferable to ligating the subclavian artery. For though in the latter case the hemorrhage would be controlled at the time, there would still remain the risk of secondary bleeding as soon as the collateral circulation was well established.

If the axillary artery is tied, and secondary hemorrhage follows, the only alternative left to the surgeon is amputation at the shoulder-joint.

Laceration of the axillary veins.—There are extravasations of blood met with after the use of forcible measures at reduction, which come from comparatively small vessels, chiefly veins, which, though they cause the surgeon some uneasiness, are not of sufficient gravity to justify any operative measures beyond pressure and the application of cold. To distinguish these collections from those which are due to a rupture of the main artery or vein, attention must be given to the rapidity with which the swelling forms, the absence or presence of the radial pulse, the color of the face, and the strength of the patient.

In the paper of Dr. Willard, to which allusion has been made, 2 cases of rupture of the axillary vein are recorded; 1 by Froriep and 1 by the author. The first proved fatal, the last recovered. There are also noticed 3 cases in which both the axillary artery and the axillary vein were torn, 2 of which were fatal, and 1 was not determined. We have, then, a total of 24 cases of rupture of the axillary vessels, 15 terminating fatally, 2 uncertain, and 7 recovering.

Injury of nerves.—The axillary plexus of nerves or some of its branches may be damaged in these forcible attempts to reduce an old luxation of the humerus, causing paralysis of the entire arm, or of certain groups of muscles.

Fracture.—Several times has the humerus been broken while efforts were being made to replace an old dislocation. Hamilton notices three instances of this complication. The same accident happened in my own experience while attempting to reduce an old dislocation of the humerus in an aged female, before a medical class at the Pennsylvania Hospital. A similar fracture occurred in the hands of Dr. Hunt at the same institution, and under like circumstances. In my own case, the bone gave way at the surgical neck, and during rotation. In two of the cases noticed by Hamilton, it was during the same kind of movement that the humerus gave way. When the fracture takes place at the surgical neck, I do not regard it as a calamity, but rather

* Warren, *American Journal of the Medical Sciences*, vol. xi., New Series, 1846.

as a desirable occurrence, since by keeping up repeated movements a false joint can be established, which will in a great measure restore the usefulness of the limb; such was the result in my own case.

Diffused abscess.—The inflammation which ensues upon the forcible disruption of old adhesions between the head of the bone and the tissues of the axilla may be followed by abscess. Mr. Hutchinson, of London, lost a patient from this cause.

Fracture of the lip of the glenoid cavity of the scapula may accompany a luxation. It is caused by the head of the bone being violently impelled against the margin of the articulating cup. This lesion existed in one of Professor Gibson's cases of old luxation.

The accident may be suspected when, after reduction, the head of the bone has a tendency to slip from its articulating surface; and the suspicion will be further confirmed if, in addition to the tendency to a recurrence of the dislocation, *crepitus* can be developed. Extensive rupture of the capsular muscles will strongly resemble this fracture. But in rupture of the capsular muscles there will be *no crepitus*.

The treatment will consist in immobilizing the joint and arm, by placing a stout pad in the axilla and securing the arm to the body with a Velpeau roller.

Fracture and dislocation may occur *simultaneously*,—that is, the same force which displaces the bone may fracture it. In such cases the fracture is generally in the neck of the humerus, near to its head. (Fig. 945.)



FIG. 945.
Unreduced luxation of the humerus, with fracture in the neck of the bone.

The nature of this injury can be determined by finding that the head of the bone is not affected by the movements of the arm, and also by the presence of *crepitus* when the broken surfaces of the bone are rubbed together.

The patient being etherized, the head of the bone should be pressed back into the glenoid cavity with the fingers, after which the fracture must be dressed in the manner directed for the treatment of a fracture through the surgical neck of the humerus.

Compound dislocation.—In very rare instances, the head of the humerus, after escaping from the glenoid cavity, may be forced through the soft parts. If the vessels remain untorn and the head of the bone sound, the luxation should be re-

duced and the wound closed. If the head of the bone is broken, it will be safer to remove it before replacing the humerus.

When the axillary artery is torn, the limb should be amputated at the shoulder-joint.

When I was in Vienna, a very unique specimen of a dislocated humerus was shown to me in the museum of the University. The head of the bone had been driven through an intercostal space into the cavity of the thorax, pushing before it the pleura. The history of the accident, I was informed, was not certainly known; but it was very evident that the patient had recovered from the injury, as the repair between the walls of the chest and the bone was complete. Larrey, in speaking of this same specimen, says that he was informed by Professor Prochaska that the dislocation was produced by a fall upon the elbow while the arm was extended, and that the patient was a young man about sixteen, and lived to the age of thirty, dying from causes altogether unconnected with this injury. The most persistent efforts had been made to reduce the luxation, but without success.

Fracture of the ribs.—Such a fracture may be produced either by the heel of a boot against the chest, or by other counter-extending force; or the accident may follow the violence inducing the dislocation. Such frac-

tures explain the emphysema, first observed by Desault, which in rare instances has been noticed over the chest after a dislocation, and which is no doubt the result of a wound of the lung inflicted by a fragment of a broken rib.

The treatment will not differ from that appropriate for fracture from ordinary causes.

SIMULTANEOUS LUXATION OF BOTH HUMERI has been observed in a few instances. The displacement is generally produced by falling upon the hands when the arms are outstretched to protect the body from injury. Examples of this accident have been noticed by Van Buren, Cowper, Pardee, Geddings, Nathan Smith, Holmes, and others. The accident, in the case reported by N. Smith, occurred during a powerful convulsion.

The reduction of these double dislocations is accomplished upon the same principle as that laid down for the management of the usual form of the scapulo-humeral displacement.

Dislocation of the tendon of the biceps muscle is an injury which I have never witnessed independent of a luxation of the humerus. I am at a loss to conceive how such a displacement can take place, except as the result of pathological changes (as *osteo-arthritis*), of which Fig. 946 is a good illustration.

CONGENITAL DISLOCATIONS OF THE HUMERUS.—These rare luxations are not unfrequently associated with malformations in other joints. Only two varieties of the displacement have been noticed,—the *subcoracoid* and the *subacromial*,—which have been described by Mr. R. W. Smith in his work on Fractures.

The symptoms of this luxation are the same as those which accompany subcoracoid and subspinous displacements of the bone arising from traumatic causes. There has been observed in the congenital dislocations a remarkable atrophy of the upper arm, while the forearm retains its natural size.

As these abnormalities co-exist with defective development of the articular ends of the bones constituting the joint, they do not, in most instances, admit of successful treatment. In one case, however, Gaillard* succeeded in permanently restoring the humerus to its articulating cavity. The patient was a girl sixteen years of age. Before the final efforts at reduction were made, the bone had been well loosened from its abnormal position by repeated manipulation.

A case which was shown to me as one of congenital luxation of the humerus I decided to have been produced during a difficult labor, by the traction which was made on the arm to effect delivery. It is not improbable that such may have been the origin of other cases recorded as congenital dislocations.

DISLOCATIONS OF THE BONES OF THE FOREARM.

Dislocations of one or both of the bones at the elbow-joint are not uncommon accidents. Considering the extent and complexity of the articulation, and the serious inconveniences which result from defective motion of the forearm, they demand a most careful consideration.

These dislocations are most common during early life. Of 113 cases admitted to the Pennsylvania Hospital, 51 were in boys under fifteen years of age, 24 occurred between the ages of fifteen and twenty-five years, 20 be-

FIG. 946.



Displacement of the head of the humerus, with destruction of the tendon of the biceps muscle. From a specimen in the museum of the College of Physicians, Philadelphia.

* Mémoires de l'Académie de Médecine, 1841; Maligne, p. 569.

tween twenty and thirty-five years, 12 between thirty-five and forty-five, but only 6 after forty-five years. Of these dislocations, 105 were in males and 8 in females.* Professor Hamilton,† in an analysis of 60 cases, found the average age to be about twenty years. Of this entire number, 23 were in children under fourteen years of age. The statistics of the Middlesex Hospital, according to Holmes,‡ furnish 73 instances of elbow dislocations, 48 of which occurred in children between five and fifteen years of age. At Guy's Hospital,§ the proportion of children has not been so great, only 6 cases between ten and twenty having been reported.

The dislocations of the bones of the forearm are as follows:

First, dislocation of the radius from the humerus,—*humero-radial*,—sometimes called radio-ulnar dislocation; second, dislocation of the ulna from the humerus,—*humero-ulnar*; third, dislocation of both the radius and the ulna from the humerus, frequently designated as a *luxation of the elbow*; and, fourth, dislocation of the inferior extremity of the ulna from the radius, often described as *inferior radio-ulnar displacements*.

Radio-Humeral Dislocations.

The head of the radius may be detached from the sigmoid cavity of the ulna and from the humerus, and be displaced in three different directions,—*forward*, *backward*, and *outward*. In these dislocations the lateral and annular ligaments are torn, and the head of the bone rests in front of, behind, or external to the external condyle of the humerus.

The accident is very frequently overlooked; at least I have seen quite a number of unreduced luxations of this bone.

Dislocation Forward.—This luxation is by far the most common. It may be produced by a fall upon the hand while the latter is in a state of forced pronation, by a force applied to the outer side of the elbow, or by the struggles of a child held by the hand and endeavoring to release itself from the grasp.

SYMPTOMS.—The radial side of the forearm is somewhat shortened and inclined outward. A depression exists immediately below the external con-

dyle of the humerus, being the vacated sigmoid cavity of the ulna. The head of the bone can be felt in front of the elbow (Fig. 947), and may be recognized by its movements if the thumb is placed upon it while the forearm is supinated and pronated. The biceps muscle is relaxed, as is the supinator,



FIG. 947.

Position of the head of the radius in an anterior luxation.

and hence the hand is found either in its natural position or slightly pronated. The forearm cannot be thoroughly extended, and flexion, when carried beyond a certain angle, is suddenly arrested by the head of the radius striking against the front of the brachialis anticus.

TREATMENT.—A little forcible flexion of the forearm being made in order to relax still more the biceps muscle, extension should be made from the hand, and counter-extension from the arm by the assistants, while the surgeon presses the head of the bone downward and outward towards the sigmoid cavity of the ulna, at the same time directing that the hand shall be pronated.

If successful in effecting a reposition, it will require the utmost care to

* Alison's Manuscript Tables.

† Hamilton on Fractures and Dislocations, 5th ed., p. 626.

‡ Holmes's System of Surgery, vol. ii. p. 764.

§ Bryant's Surgery, p. 725.

prevent a recurrence of the displacement. The forearm must be maintained in the flexed position, at a right angle, by either an anterior or a posterior angular splint. This should be secured with a roller bandage, interposing, if necessary, a firm compress over the head of the radius. This dressing should not be removed for at least two weeks, unless there is reason to believe that the bandage is too tight, or that excoriation exists. It will require at least two months before the ligaments shall have united sufficiently to give a reasonable security to the bone.

The treatment of this luxation is, however, most unsatisfactory, even when the patient is seen immediately after the injury. Great difficulty will usually be experienced in effecting the reposition, or, if successful in this, in retaining the head in its normal position.

After the bone has been out of place for a few days, in most instances, its reduction will be a matter of impossibility. Notwithstanding the irreducibility of the luxation, the usefulness of the limb is not materially impaired. The head of the radius soon establishes for itself an excavation in its new situation, in front of the brachialis anticus muscle, having the sphere of its movements circumscribed by a wall of condensed connective tissue, similar to a capsular ligament. The movements of extension, of pronation, and of supination can be readily executed; and even that of flexion is gradually increased by a partial absorption of the head of the bone.

Partial dislocation of the radius forward may occur when the coronary ligament alone is torn. The treatment will be the same as in the complete luxation.

Dislocation Backward.—In this displacement the head of the radius escapes through a laceration in the posterior aspect of the capsular ligament, the coronary and oblique ligaments being also torn. The head of the bone rests behind the external condyle of the humerus.

This accident is comparatively rare, there not being, according to Hamilton, more than about twenty-eight examples of the injury recorded. According to Markoe, of New York, this dislocation is usually associated with a fracture of the internal condyle of the humerus.

CAUSES.—This dislocation may either follow a blow in front of the head of the radius, or may be caused by a fall upon the hand when the bones of the arm are in a state of extreme pronation. It has also been produced in the act of wringing out clothes,—a movement involving very forcible pronation of the hands.

SYMPTOMS.—The forearm is found slightly flexed by the tension of the biceps; the hand is pronated, slightly flexed and fixed; supination is impossible; a depression can be felt below the external condyle of the humerus, answering to the position of the sigmoid fossa. A hard round tumor can be discovered behind the condyle, which can be identified as the head of the bone, both by its form and by its movements, which correspond to those of the bones of the forearm. Both flexion and extension are greatly abridged. (Fig. 948.)

TREATMENT.—An assistant makes counter-extension from the arm, while the surgeon, grasping the hand, makes extension, followed by supination, pressing at the same time the head of the bone forward towards its articulating cavity. After the reduction, the forearm and arm should be placed on an anterior angular splint, the angle being *very obtuse*, so as to give greater security to the reduction.



FIG. 948.

Position of the radius behind the external condyle in a posterior luxation.

When the dislocation is *conjoined with a fracture of the internal condyle*, the same dressing will be indicated.

Dislocation Outward.—The head of the bone, to occupy a locality *directly* outward, would have to rest upon the epicondylar ridge,—a position so extremely improbable that it is questionable whether such a dislocation, in the strict sense, ever occurs. The head of the bone in an anterior displacement may rest on the flat surface of the humerus, immediately inside of the epicondylar ridge; and in this situation it resembles an external displacement, though it is in reality an anterior one. The interosseous ligament will probably be detached at the upper extremity of the bones, so as to admit of their separation.

SYMPTOMS.—The signs of this presumptive dislocation are undue prominence above and a little in front of the external condyle of the humerus; the forearm is fixed, placed between pronation and supination, neither of which motions can be executed, except with difficulty; and an unusually prominent line, corresponding to the upper fifth of the radius, is found on the outer aspect of the forearm. Flexion and extension, though much abridged, are not destroyed.

TREATMENT.—This will consist in making extension and counter-extension while the arm is moderately flexed, and at the same time pressing the head of the bone downward and forward. The limb will require to be fixed in the same angular dressing as in the usual form of radio-ulnar displacements.

Dislocation of the Ulna from the Humerus.—This luxation, though well established, is by no means a common accident. It consists in a posterior displacement of the ulna upon the humerus, the radius continuing to maintain its functional position against the external condyle. The coronoid process slides back to the margin of the olecranon fossa, or it may rest on the posterior face of the internal condyle of the humerus. In either case the upper part of the interosseous ligament will be torn. (Fig. 949.)

FIG. 949.



Backward dislocation of the ulna.

Dislocations of the Radius and Ulna.—This injury requires for its production a violent force applied to the hand while the forearm is flexed on the arm, and, in addition, some unusual twist affecting the relation of the bones in a manner which it is not easy to understand.

The reduction is best accomplished by making extension and counter-extension around the knee placed in the bend of the arm.

This luxation may take place in four directions,—*backward, forward, outward, and inward*. A variety of the last-named displacement may be termed *postero-lateral*.

Dislocation Backward.—This is the most common displacement of the elbow-joint. It results from force concentrated on the articulation when the latter is in a vulnerable position,—as when an individual is dashed headlong from a vehicle and strikes upon the hands while the forearm is flexed upon the arm. It may also be produced by the limb being caught in the belting of machinery, in which it is wrenched, twisted, and bent in a manner so sudden and rapid as to defy any attempt at analyzing the order of the violence.

In this displacement the anterior and lateral ligaments are torn, and the two bones, retaining their parallelism, slip behind the humerus; the coro-

noid process of the ulna drops into the olecranon fossa of the humerus, and the radius occupies the posterior surface of the external condyle. The brachialis anticus muscle is rendered tense over the articular surface of the humerus, while the tendon of the biceps is only slightly stretched. (Fig. 950.) Both the median and ulnar nerves are exposed to pressure. The ulnar and interosseous vessels may also be subjected to compression.

It is not uniformly the case that the bones of the forearm are placed as represented above. The coronoid process of the ulna may, by the action of the triceps, be drawn above the olecranon fossa, or it may stop short of that cavity, the head of the radius preserving the relative level on the posterior surface of the humerus.

SYMPTOMS.—The signs of a posterior dislocation of the elbow are very characteristic. The forearm is somewhat flexed on the arm and shortened anteriorly; a prominence exists in front of the elbow, formed by the lower extremity of the humerus; and another prominence posteriorly, made by the olecranon process of the ulna and the tendon of the triceps muscle. (Fig. 951.) Flexion and extension of the forearm are, as a rule, made with difficulty, and the hand is, in consequence of the slight tension of the biceps tendon, frequently in a state of supination.

DIAGNOSIS.—Between dislocation of the elbow and supra-condyloid fracture of the humerus there are several features of resemblance. But the two injuries may be distinguished from each other by observing the following points:

FIG. 950.



Relation of the bones and muscles in a posterior dislocation of the bones of the forearm.

FIG. 951.



Appearance of the limb in a dislocation of the elbow.

DISLOCATION OF THE ULNA AND RADIUS BACKWARD.

Olecranon process is above the level of the internal and external condyles of the humerus.

Lower end of the anterior prominence smooth and rounded and broad, being the articular end of the humerus.

Flexion and extension difficult, the forearm being rigid and fixed.

The posterior projection is increased by flexion and diminished by extension.

Reduction once effected by extension and counter-extension, the deformity permanently disappears.

No crepitus.

Forearm shortened anteriorly.

FRACTURE ABOVE THE CONDYLES OF THE HUMERUS.

Olecranon process is on a line with the internal and external condyles of the humerus.

Lower end of the anterior prominence irregular, probably spiculated, and not broad.

Flexion and extension easy; forearm movable.

Posterior projection diminished by flexion and increased by extension.

Reduction easily accomplished by extension and counter-extension, but the deformity immediately reappears on the withdrawal of these forces.

Crepitus.

Forearm not shortened anteriorly.

If the summit of the olecranon process of the ulna and the internal and external condyles of the humerus are found to be on a line, the surgeon may confidently assert that there is no luxation of the bones of the forearm.

TREATMENT.—The reposition of a luxated elbow is usually very easily accomplished when brought early to the attention of the surgeon. But if it is not detected, or if allowed to remain even for a single week, the difficulties of reduction are immensely increased; and often, after the lapse of four or five weeks, they become insurmountable. The practitioner is not, however, to decline making an attempt to restore a displacement of this articulation, even after a much longer period has passed than the one just mentioned. Numerous instances are recorded in which old dislocations of this joint have been successfully treated by Sir Astley Cooper, Malgaigne, Roux, and others. Brainerd, of Chicago, reduced a luxation of the elbow-joint of five months' standing; Westmoreland, of Georgia, one after the same length of time; Gerdy and Drake each one of six, and Hamilton one of seven, months' standing. Among the number of these old luxations collected by Denucé is one which is said to have been reduced by Starch two years and one month after the accident. I have succeeded, in two instances, in replacing a dislocation

of these bones, one after four and one after six weeks, with almost as much facility as if the attempt had been made a few days after the injury.

In cases of luxation at the elbow where difficulty is anticipated, an anæsthetic should be given prior to the employment of any measure for reduction. Different methods are employed to reduce this luxation. That adopted by Sir Astley Cooper will be found to succeed perfectly well for recent cases. It is to seat the patient on a stool or a chair, while the surgeon, placing his foot on the same and planting his knee on the inner side of the elbow, seizes the injured limb at the wrist with both hands and bends the forearm forcibly around his leg. (Fig. 952.) The main object is to lift the coronoid process out of the olecranon fossa, when it will be drawn into place by the brachialis anticus muscle. The knee, in order to fulfill this indication, should be so placed against the bend of the elbow that, while it firmly fixes the humerus, its inner side can be used as a fulcrum for the radius and ulna, and thereby enable the operator not only to raise the



Reduction of a dislocated elbow with the knee in the bend of the arm.

coronoid process, but also at the same time to separate the bones of the arm and the forearm, and thus remove all impediments to the reposition.

Professor Gross adopts a plan which is equally efficient with that of Sir Astley Cooper. The surgeon, carrying his limb across the body of the patient, places his foot in the bend of the arm, and makes extension from the wrist.

The arm has, in some cases, been bent round a bedpost, with the effect of quickly reducing the dislocation.

Dorsey's plan, which is a very good one, consisted in having extension and counter-extension made, while the surgeon, locking the fingers of the two hands over the inner surface of the bend of the elbow, and placing the two thumbs against the olecranon process, forced the latter downward, at the same time drawing the elbow backward so as to increase the flexion of the arm.

Instead of flexion, forcible extension of the arm has been used with success by Waterman. In adopting this mode of reduction, the forearm must be forcibly extended. By this movement the ulna becomes a lever of the third kind. Its fulcrum, at the extremity of the olecranon process, is forced against the posterior surface of the humerus, and in this manner the coronoid is lifted out of the olecranon fossa, when, by making extension and counter-extension, it is dragged over the trochlear surface of the humerus into its proper position, by the contraction of the brachialis anticus muscle. In cases demanding the use of much force, as in old luxations, extension and counter-extension must be made by bands attached to the forearm and the arm and committed to assistants to pull upon. If a more steady and a greater amount of power is required, to the extending bands should be attached the compound pulley. While these forces are being exerted, the surgeon must, by means of a folded sheet placed round the elbow, draw the latter directly backward, or at a right angle with the extending and counter-extending forces. Or he may, after the manner of Dorsey, accomplish the flexion with his hands, at the same time pressing with his thumb the olecranon process downward. Crosby, of New Hampshire, in two cases, succeeded in replacing old luxations of the elbow, after fracturing the olecranon process in bending the arm. Mussey, of Cincinnati, was also able to reduce one case, and Hamilton three cases, by the same procedure. The same plan was adopted by Professor Gross, with a satisfactory result.

Hamilton, in an obstinate case of an old dislocation of the elbow backward, effected the reposition, after dividing the tendon of the triceps muscle subcutaneously.

The suggestion to divide through the interior of the joint whatever may oppose the restoration of the bones may in old luxations, by wounding vessels and nerves, be followed by graver evils than the disability it is proposed to remedy.

Notwithstanding that it has been possible occasionally to overcome all difficulties and return the bones to their true functional position, these triumphs, when compared with the many failures, are highly exceptional, and have not unfrequently been won at the cost of a ruptured brachial artery, the laceration of an important nerve, the induction of gangrene, the loss of an arm, and even, as in Velpeau's patient, of life itself. In consideration of these facts, I am prepared to condemn all *persistent* attempts to reduce, by extraordinary force, old luxations of the elbow-joint.

It will be wiser to fracture the olecranon, and by regularly-enforced motion to restore, in this way, the usefulness of the limb. The operation is easily executed by perforating the base of the process at two or three points with a fine drill, and afterwards breaking it away from the upper end of the shaft of the bone by forced flexion of the arm.

In reduction, the return of the bones to their proper place is generally announced by a slip, or a sound which is quite characteristic. The deformity disappears, the true rectilinear relation of the olecranon process and the condyles of the humerus is re-established, and the forearm can, without resistance, be flexed to a right angle with the arm. The last two signs of a successful reduction should be carefully noted. If one is absent, the other will be absent also; and when this is found to be the case, the surgeon may rest assured that the reposition is not complete.

After the bones have been replaced, it will be necessary to combat the secondary inflammation by the application of lead-water and laudanum, or by the use of ice-bags around the joint. To guard against the recurrence of the dislocation by any careless movements of the arm, an angular splint may be loosely attached to the anterior surface of the limb. In a docile, intelligent patient the splint is not necessary, only requiring that the arm be supported on a pillow or in a sling. After six or seven days, when the inflammation is on the decline, careful movements of the articulation must be commenced in order to prevent stiffness.

Complications.—The complications which may possibly accompany luxation of the elbow are supra-condyloid fracture of the humerus, fracture of one of the condyles,—generally the internal,—and fracture of the olecranon or of the coronoid process of the ulna.

The signs of a supra-condyloid fracture have already been noticed. When a condyle is detached, it can be recognized by the presence of unusual mobility, and by crepitus.

Fracture of the olecranon can be discovered by grasping the process between the thumb and fingers and finding its movements to be entirely independent of those of the ulna.

Fracture of the coronoid process—a rare occurrence—is indicated when, after reduction, there is a constant tendency to displacement, and, perhaps, by the presence of crepitus.

All of these injuries complicate the dislocation more or less by increasing the risk of ankylosis or of defective movements in the joint.

When the olecranon has been broken, it will be necessary, in order to bring the detached process into proximity with the shaft of the bone, to place the limb in a moderately extended position, and, to prevent the triceps muscle from drawing the fragment upward, the middle of a long strip of adhesive plaster should be applied above the process. The ends of the strip, being drawn downward and forward, can be secured by first crossing them in front below the elbow, and conducting them again to the back of the forearm, where they are to be fastened. A splint with a very obtuse angle, secured to the front of the limb, will complete the dressing.

A like plan of treatment will answer when there is reason to believe that the coronoid process has been broken.

When the fracture is supra-condyloid or condyloid, two angular splints should be used,—a flat one for the anterior and a concave one for the posterior aspect of the limb.

Dislocation Forward.—In looking at a ligamentous preparation of an elbow-joint, independent of clinical experience, it would seem to be impossible that a dislocation of the bones of the forearm forward could take place without a precedent fracture of the olecranon process. Several examples, however, have been observed in which the signs were so entirely corroborative of the accident that little doubt of its reality can remain. Colston, Lana, and Delpech each claim to have witnessed the accident. Dr. Forbes, of Philadelphia, met with one case of the injury; Hunt, of Chicago, with another; and six other cases are recorded by Hamilton, viz., those of Monin, Prior, Velpeau, Canton, Denucé, and Longmore, of London.

This dislocation may be *complete* or *partial*.

To effect such a displacement without a fracture of the olecranon process must necessarily require that the forearm be carried very much off in a lateral direction, and afterwards subjected to a violent twist, the olecranon not coming directly forward, but describing, in a lateral direction, the segment of a circle.

SYMPTOMS.—When the dislocation is *complete*, the radius and ulna occupy a position in front of the humerus, the head of the radius resting on the coronoid fossa, or lying a little to its outer margin; the posterior face of the ulna then lies in contact with the front of the inner condyle, or on the inner side of the coronoid fossa. (Fig. 953.) The arm is shortened and flexed.

The broad, rounded surface of the humerus will be felt posteriorly, with the olecranon process and the head of the radius anteriorly. The latter may be recognized by its movements under the

FIG. 953.



Anterior dislocation of both bones of the forearm.

thumb, when the hand is greatly pronated and supinated. The sigmoid cavity may also be distinguished.

When the dislocation is *partial* or incomplete, the extremity of the olecranon process rests upon the lower end of the articulating surface of the humerus. In this case the forearm is lengthened and somewhat flexed.

TREATMENT.—When the luxation is complete, it must be reduced by making forced flexion of the forearm. If this plan alone fails, it may be tried again conjointly with extension made from the wrist and counter-extension by the foot or by bands from the arm.

When the dislocation is partial, the reposition can be accomplished by forcing the arm forward and the forearm backward while extension and counter-extension are being made.

Lateral Dislocations.—These displacements may occur in two directions,—*outward* and *inward*. The first is the more frequent form, though either must be regarded as a very unusual accident.

These dislocations, with few exceptions, are incomplete. They are caused by violence acting on the upper and lower arm in opposite directions, as when the limb is wedged between the spokes of a wheel and the side of a wagon, or when, in heavy falls, the resistance of the ground on the hand and the weight and momentum of the body are received when the limb is in a position favorable to the expenditure of the force upon the lateral ligaments of the joint.

SYMPTOMS.—When the dislocation is incomplete and *outward*, the ulna is not entirely removed from the trochlear surface of the humerus. But it is shifted to its external side, resting partly upon the external condyle. And the same is true of the radius, provided the determining force has not ruptured the coronary ligament. The head of the bone either remains in contact with the outer margin of the radial surface of the humerus, or rests between the latter and the epicondylod eminence. (Fig. 954.)

Where the displacement approaches more nearly to the complete form, the radius will be carried entirely clear of, and external to, the external condyle, while its articulating surface on the humerus will be occupied by the sigmoid cavity of the ulna. A more extensive laceration of the radio-ulnar ligaments may destroy the parallelism between the radius and the ulna, allowing the head of the former bone to occupy a plane either anterior or posterior to the ulna. These changes in the relations of the bones of the forearm and arm give rise to the following symptoms, namely, a variable degree of flexibility of the forearm, a marked projection on the inside of the elbow, made by the internal condyle of the humerus, and a lesser prominence posteriorly, formed by the olecranon process of the ulna. On the outer side of the articulation the head of the radius will be apparent. By rotating the bone, it can be seen and felt to move underneath the integument. (Fig. 955.)

In the *inward dislocation*, rarer than the one just described, and always incomplete, the ulna rides the internal condyle, and the head of the radius rests in one of three positions, viz., against the lower surface of the trochlea of the humerus, normally occupied by the great sigmoid cavity of the ulna, or slightly on either its anterior or posterior face. (Fig. 956.)

Should the ulna be displaced behind the internal condyle of the humerus, the head of the radius will slip back into the olecranon cavity, forming a *postero-lateral* dislocation.

SYMPTOMS.—The arm is flexed, inclines inward, and is shortened along its ulnar border. The internal condyle becomes indistinguishable by the projection of the olecranon process of the ulna. The external condyle is rendered unusually conspicuous by the absence of the head of the radius from its capitulum. And the hand is pronated by the tension made upon the pronator radii teres muscle.

In the *postero-lateral* luxation, in addition to the prominence made by the external condyle of the humerus, the arm will be shortened anteriorly; and

the projection of the olecranon process of the ulna will be felt immediately behind the external condyle of the humerus.

TREATMENT.—The reduction of the outward and inward luxations is effected

FIG. 954.



Outward dislocation of the forearm.

FIG. 955.



Deformity in outward dislocation of the forearm.

FIG. 956.



Inward dislocation of the forearm.

by grasping the forearm with one hand and the arm with the other, near to the elbow, and, while extension and counter-extension are being made, by forcing the humerus and the bones of the lower arm in opposite directions.

The postero-lateral luxation should be treated as a posterior dislocation, by bending the front of the elbow around the knee, or by flexion and extension, conjoined with lateral pressure.

I have never witnessed a dislocation of this nature, and therefore have no experience of the difficulties attending its reduction. Malgaigne, who appears to have seen four cases of the injury, was unable to replace a single one.

Compound Dislocations of the Elbow.

Of 113 dislocations of the elbow treated in the Pennsylvania Hospital, 4 were compound. Though exceedingly grave injuries, they do not necessarily cause the loss of the arm. The only circumstances which will justify a resort to amputation are lacerations of the principal blood-vessel, or extensive fractures of the bones, with wide-spread mutilation of the soft tissues.

In the absence of these, there are two plans of treatment open to the surgeon's choice. The first is to replace the bones, to close the wound, and to moderate as much as possible the resulting inflammation and suppuration; the second, to make a partial or complete resection of the bones, and afterwards proceed as in the first method.

I have practiced both plans, but give a decided preference to *partial resection*. When the opposite plan is pursued, the muscular tension, pain, and spasm which attend the ensuing inflammation give rise not only to severe constitutional disturbance, but to diffuse abscess, which is likely to prove ruinous to the structures of the entire limb. These dangers were well known to the ancient surgeons, some of whom advised non-reduction, and most amputation. It will, therefore, greatly contribute to the success of a case of compound

luxation of an elbow-joint to remove the projecting ends of the ulna and radius, so that they can be readily replaced and will lie easy and free from all pressure within the wound.

The operation and dressing should be conducted under the carbolic acid spray, accompanied with all the details of the antiseptic treatment.

Dislocation of the Inferior Radio-Ulnar Articulation.—In this dislocation the lower extremity of the ulna is separated from the semilunar cavity of the radius, and may be displaced in two directions, viz., *backward* or *forward*. The former is slightly the more common of the two. These luxations rarely occur independent of a fracture of the radius. There is an incomplete or partial form of this displacement which I have observed in a number of instances.

Backward Dislocation is the result of extreme and violent pronation of the hand. It may also follow a comminuted fracture at the carpal extremity of the radius. The posterior radio-ulnar and the sacciform ligaments will be ruptured, and the triangular interarticular cartilage disconnected at its apex from the root of the styloid process of the ulna.

SYMPTOMS.—The signs of the injury are the following: a marked and movable prominence at the back of the wrist at its outer border, either rising above the plane of the radius or crossing in front of the latter; the styloid process is no longer in line with the fifth metacarpal bone; a cord—the tendon of the extensor carpi ulnaris—may be seen, over which the skin is stretched, rising from the lower fifth of the ulna and descending towards the metacarpal bone of the little finger; the hand is in a state of pronation, and the fingers are somewhat flexed.

TREATMENT.—The hand must be extended, in order to relax the extensor carpi ulnaris muscle; and the end of the bone at the same time should be pressed directly backward into its semilunar cavity. After the reduction, the tendency to relaxation can only be prevented—especially when the laceration of the ligament has been extensive—by the use of a Bond's splint and a firm compress bound over the posterior surface of the bone. Even after the removal of the splint, which should not be earlier than four weeks, it will be a wise precaution to substitute in its place an *elastic armlet*, to be worn for three or four months, or until the repair of the ligaments of the joint has been completed.

Dislocation Forward.—The dislocation forward demands for its production a violent supination of the hand, by which the rounded surface of the ulna is pressed strongly against the anterior ligaments of the joint and ruptures them.

The statistics of the anterior dislocation of the ulna, collected by Malgaigne and by Hamilton, prove the injury to be almost as common as the displacement backward.

SYMPTOMS.—An unusual projection is seen immediately above the hand and somewhat across the face of the radius, where it is drawn by the pronator quadratus muscle; on the back of the wrist the usual rotundity of the lower end of the ulna is absent; the hand is supinated and the fingers are flexed.

TREATMENT.—The reduction is performed by first flexing the forearm, and then, while making at the same time extension from the hand, counter-extension from the arm, and forced pronation, by pressing the hemispherical head of the ulna back towards the semilunar cavity of the radius.

The subsequent dressing should consist of two flat, well-padded, plain splints, secured to the limb by a roller, and extending the anterior one from the bend of the elbow to the extremities of the fingers, and the posterior one to the carpus.

Partial Luxation.—This displacement is sometimes met with after severe twists of the wrist, or, more commonly, after badly-treated fractures at the

lower end of the radius, leaving the hand in a state of abduction. Under such circumstances, from the strain to which the inferior radio-ulnar ligaments may have been subjected at the time of the accident, causing a rupture of some of their fibres, or from the continued tension exerted on the articulation by the malposition of the hand, the sacciform and other ligaments become expanded or elongated, so as imperfectly to confine the head of the ulna in place.

SYMPTOMS.—This condition may be recognized by the unusual external and posterior prominence of the lower end of the ulna, by the great mobility of the same, and by the weakness of the wrist which exists.

TREATMENT.—The displacement is irremediable, consequently the treatment must be one of palliation. A strip of muslin or of flannel bound firmly about the wrist gives the best protection to the joint.

DISLOCATIONS OF THE HAND.

Dislocations of the hand include those of the *carpus*, the *metacarpus*, and the *phalanges*.

Dislocations of the Carpus.

Nothing perhaps more conspicuously exhibits the accuracy with which the investigation of surgical injuries has been pursued than the surgery of wrist dislocations. Among the older surgeons these luxations were regarded as very common accidents. It was only after Poteau called attention to the peculiarities of fractures at the lower end of the radius that the occurrence of these so-called *carpal* dislocations began to be challenged. Dupuytren barely admitted the possibility of the injury. Desault also had expressed the opinion that fractures at the wrist were often mistaken for luxations. The cases of carpal dislocation, uncomplicated by fracture, which have been verified by dissection are so few that it must be regarded as an injury of exceedingly rare occurrence. The power of the radio-carpal joint to escape dislocations arises from the resistance of the strong ligaments, the numerous flexor and extensor tendons (which run over the anterior and posterior aspects of the joint) being confined in their places by the anterior carpal ligament in front, and by the osteo-fibrous canals on the back of the wrist. To these peculiarities of anatomical structure must be added the liability to fracture of the lower extremity of the radius from the manner in which the carpus is impelled against or bent upon the end of the bone in the reception of ordinary injuries, when the force is transmitted from the hand to the wrist-joint. The concavity (between the styloid process of the radius and that of the ulna) for the reception of the scaphoid, semilunar, and cuneiform bones of the carpus is so deep, and the lateral ligaments so strong, that a luxation of the carpus must be *backward* or *forward*. A lateral luxation would only be possible after a fracture of one or the other of the styloid processes.

Dislocation Backward.—This displacement may follow the application of force to the back of the hand, in consequence of which the latter is flexed to a degree which results in the rupture of the posterior radio-carpal and lateral ligaments, and in the detachment of the fibrous arches over the grooves on the back of the radius, thus allowing the carpus to be lodged on the posterior surfaces of the radius and ulna. (Fig. 957.)

SYMPTOMS.—One sign of a dislocation of the carpus backward is the great *thickness* in the antero-posterior diameter of the wrist, the upper end of the dorsal prominence being the rounded surface of the carpus, and the lower end of the palmar prominence being the broad and less regular extremities of the radius and ulna, the styloid processes of which may be felt. The hand also will be a little extended, the fingers flexed, and the forearm shortened. (Fig. 958.)

TREATMENT.—Grasping the hand of the patient, palm to palm, extension should be made, the surgeon at the same time imparting a *lever-like* motion

FIG. 957.



Dislocation of the carpus backward.

FIG. 958.



Deformity after a backward dislocation of the carpus.

to the carpus,—that is, by making slight flexion, extension, abduction, and adduction.

A sudden slip and the disappearance of the deformity, without any tendency to its return when the extending force is removed, are the indications that the reduction has been complete.

Dislocation Forward.—In this variety of the injury the anterior radiocarpal and some fibres of the lateral ligaments are torn, and the bones of the carpus occupy the anterior surface of the radius. (Fig. 960.)

FIG. 959.



Deformities after anterior dislocation of the carpus.

FIG. 960.



Anterior dislocation of the carpus.

SYMPTOMS.—This luxation is known by the peculiar prominences at the wrist, the posterior being more marked and less regular than the anterior. The arm is shortened, and the hand and fingers are extended.

TREATMENT.—The reduction is effected by making traction from the hand, as in the preceding dislocation. At the same time, the carpus is extended upon the arm, and the anterior or carpal prominence is pressed downward.

After the reposition, the articulation should be enveloped in a lotion of lead-water and laudanum, and be supported for six or eight days on a Boston splint. As soon as the inflammatory swelling begins to subside, passive motion must be commenced, with a view to prevent ankylosis of the joint.

DIAGNOSIS OF CARPAL LUXATIONS.—The fact that fractures at the lower extremity of the radius are often diagnosed as carpal luxations constitutes a sufficient reason, before dismissing the subject, for noticing the general points of distinction. In luxation, the deformity, both dorsal and palmar, is much *more marked* than in fracture. In luxation, the hand is *not deflected* either to the right or to the left, while in fracture it is frequently inclined to the *radial* side of the arm. Except when conjoined with fracture, there is, in dislocation of the carpus, *no crepitus*. When the reduction is made in a luxation of the carpus and the extension removed, there is at once *the disappearance* of all deformity, and *without any tendency* to its reproduction. In dislocation, the reduction, when it does occur, is a *sudden* event,—it is announced by a significant slip. Finally, in fracture, the fragments resume their proper relations more gradually, requiring a certain amount of coaxing and pressure.

TREATMENT.—When the dislocation is accompanied with fracture at the end of the radius, it must be treated on the same principle as a like complication elsewhere, namely, by restoring the luxation and then setting the fracture.

Compound Dislocations of the Carpus.—An accident of this nature must be regarded as a very serious occurrence. It is necessarily rendered so by the disturbance to which so many tendons and their synovial sheaths are subjected; by the extent of the articulation; and by the exposure to injury of so great a number of blood-vessels and nerves.

Nevertheless, of such transcendent importance is the hand, that under no circumstances should it be sacrificed so long as there remains ground on which to build even the faintest hope of its preservation. The concomitant damage sustained by the parts must therefore determine the course of the surgeon in treating compound luxation of the wrist.

As long as the principal blood-vessels and nerves remain intact, even although the soft parts be extensively mutilated and the articulating extremities of the bones be comminuted, an attempt ought to be made to save the hand.

After a complete excision of the damaged bones, the parts should be replaced, a drainage-tube introduced, and the sides of the wounds loosely approximated. If the antiseptic plan of dressing is not adopted, the joint, after being placed upon a properly-padded splint, which must include also the arm and the hand, should be kept under an irrigating lotion of tepid water, medicated with a little laudanum.

If the parts become swollen and painful, or if the suppuration becomes profuse, very great relief will be experienced by enveloping the lower part of the arm, the wrist, and the hand in a warm flaxseed-meal poultice, renewing the same three or four times in the twenty-four hours.

When, in addition to the luxation, the bones are ground into fragments, the tendons lacerated and displaced, the chief vessels and nerves torn, and the other soft tissues disorganized, nothing remains but to cut off the damaged member; it is irretrievably lost.

CONGENITAL DISLOCATIONS OF THE CARPUS have been studied by Guérin, Cruveilhier, R. W. Smith, and R. Adams, of Dublin. Three forms of this dislocation are described, namely, the *backward*, the *forward*, and the *backward and outward*.

In congenital dislocations all the components forming the articulation have been arrested in their development, and they are not unfrequently associated with other structural imperfections, or with monstrosities.

The treatment of these luxations is very unsatisfactory. But enough has been ascertained to encourage a hope that, in selected cases, if the bones can be kept in position by mechanical means for a long time, the development of the articulation and of the muscles which surround it will in some measure correct the defect.

Dislocations of the Carpal Bones.

It is difficult to conceive of a more compact and securely-constructed association of bones than that constituting the carpus. Their numerous articulating facets and their powerful interlacing ligaments bind together the different pieces so solidly that the displacement of any single bone is an event of very rare occurrence. When it does take place, it is usually accompanied with other lesions, which not unfrequently result in the loss of the hand.

The concave form of the palmar surface of the carpus, and the presence of the anterior annular ligament, resisting its expansion, are inimical to an anterior displacement of the bones. Accordingly, when a luxation of any one of the carpal pieces happens, it is usually posteriorly, or towards the dorsal aspect of the hand. There are, I believe, but two instances to the contrary on record, namely, the case mentioned by Taafé, of Brighton, in which he states that the semilunar bone was displaced anteriorly, and a case occurring in the practice of Professor Chisolm, of Baltimore.

The bones most liable to dislocation are the os magnum, the semilunar, and the pisiform, and for reasons not difficult to understand. If, in a ligamentous preparation, the two rows of the carpus be partly separated, and if, in addition, the trapezium and the trapezoid on the radial side and the unciform on the ulnar side be detached from the os magnum, it will be seen that the last-named bone lies like a ball in a socket. The unciform and the pisiform, being on the outer limits of the first row, and comparatively superficial anteriorly, are necessarily exposed to injury. Moreover, the attachment of the tendon of the flexor carpi ulnaris to the pisiform renders it subject to dislocation by muscular action.

DISLOCATION OF THE OS MAGNUM.—Cases of backward luxation of the os magnum have been noticed by Boyer, Chopart, Sir Astley Cooper, and Bransby Cooper. Richerand mentions the case of a female in whom this bone was displaced during a severe labor-pain, while the woman was forcibly squeezing the mattress with her hand. Bryant states that he has known a similar dislocation to occur during the throes of parturition, while the patient was grasping a towel.

The signs of a luxation of the os magnum are so characteristic as to leave no room for mistake. A hard prominence is seen immediately behind the carpal extremity of the third metacarpal bone. As the luxation is never complete, there will usually be little difficulty experienced in pressing the bone back into its place. Some difficulty will be encountered in keeping it reduced, as in closing and flexing the hand the displacement is readily reproduced. Bransby Cooper reports the case of a patient at Guy's Hospital who was able to displace the bone at pleasure, an experiment which he frequently practiced for the benefit of the house surgeons.

After the reduction, the hand should be placed in a palmar splint, keeping the fingers extended, and interposing a compress between the bone and the roller which secures the splint to the hand and arm.

DISLOCATION OF THE SEMILUNAR BONE.—A few examples of this luxation have been noticed. Erichsen met with one at the University Hospital, London. Bryant describes a specimen of this dislocation (compound) on both sides, which is in the museum of St. George's Hospital. The injury in this case had been caused by a fall upon the hands, and the bones were displaced through the wounds in front of the wrists.

The presence, after a fall upon the hands, of a hard body, semilunar in its form, on a line with the metacarpal bone of the index finger, and immediately below the posterior margin of the carpal extremity of the radius, is the sign which declares this luxation.

The reduction is performed by making extension from the hand, and pressing the bone forward and upward. Though the disposition to relaxation is not quite so great as in the luxation of the os magnum, the same precautions

must be observed—resting the articulation upon a palmar splint, etc.—as in similar injuries of the latter bone.

DISLOCATIONS OF THE PISIFORM BONE.—South, Ferguson, Erichsen, and Gras have each had a case of this luxation. The displacement appears to have been produced by the forcible action of the flexor carpi ulnaris muscle while lifting a heavy weight.

The bone, when detached from the facet of the cuneiform bone, will be drawn up above the wrist; and it can be recognized as a hard but movable prominence in front of the arm.

Though it is extremely improbable that the bone can be retained in its normal situation, it should nevertheless be kept as near as possible to that point. To accomplish this, the pisiform must be drawn downward, the carpus being bent anteriorly upon the arm, in order to relax the flexor carpi ulnaris muscle and thus to favor the re-adjustment. A compress should be laid across the wrist, immediately above the bone, and made fast by a few circular and figure-of-eight turns with a narrow roller. After this the hand must be kept flexed by a humero-carpal handkerchief.

I am not cognizant of any recorded example of a simple dislocation of the cuneiform or the unciform bone.

Maisonneuve has reported, in the second volume of the "Memoirs of the Chirurgical Society," one case in which the second row of carpal bones was displaced posteriorly from the first row. The patient died from the effects of other injuries received at the time of the luxation.

Dislocations of the Metacarpus.

The only example of a displacement of all the metacarpal bones from the carpus of which I have any knowledge is one given by Erichsen and taken from a cast in the University College Museum. The displacement was forward. (Fig. 961.)



FIG. 961.
Forward dislocation of the metacarpus.

Hamilton gives a case in which all the metacarpal bones, except that of the thumb, had been displaced backward. The patient at the time of the accident was a corporal in the United States army at Fredericksburg, and the dislocation was produced by a ball that entered at the ulnar border of the hand and emerged at its radial border, issuing between the bones and the skin. The bones had not been reduced, but when seen four years after the injury the motions of the fingers (except the index and little fingers) were not impaired. The same author records two examples which came under his notice of posterior dislocations of the carpal extremity of the metacarpal bones of the index and middle fingers. In neither of these cases had the dislocation been reduced.

DISLOCATION OF THE METACARPAL BONE OF THE THUMB.—This dislocation may take place in either of two directions,—*backward* or *forward*. It may be either partial or complete. The backward displacement is the more common of the two. It is produced by force applied to the anterior extremity of the metacarpal bone, causing extreme flexion; or it may be produced by a fall in which the weight of the body is received on the ball of the thumb.

The *signs* of the displacement are foreshortening of the thumb, a prominence below the styloid process of the radius (formed by the carpal extremity of the metacarpal bone resting upon the trapezium), and an inclination of the thumb towards the palm of the hand, due to a slight tension of the first dorsal interosseous muscle.

TREATMENT.—The reduction is effected by the surgeon grasping the pha-

phalangeal part of the thumb and simultaneously pressing the carpal extremity of the metacarpal bone downward and forward, while an assistant makes counter-extension from the wrist. If greater force is required than that which can be exerted by seizing the thumb, the Indian puzzle or the noose may be employed.

The greatest difficulty has sometimes been experienced in repressing the tendency to relaxation. To prevent this, a plaster roller applied as a spica of the thumb, or a piece of light binders' board, softened in hot water and moulded accurately to the thenar and dorsal portions of the thumb, including also its phalangeal part, can be used with advantage.

Dislocation of the Thumb.

The phalanges of the thumb and of the fingers may be dislocated from their corresponding metacarpal bones (*metacarpo-phalangeal* luxations); or they may be displaced from one another (*phalangeal* dislocations).

DISLOCATION OF THE PROXIMAL PHALANX OF THE THUMB.—This is the most common of the metacarpo-phalangeal luxations. The displacement can occur in two directions,—*backward* and *forward*,—though the backward is much the more common form in which it happens.

The Backward Dislocation of the First Phalanx of the Thumb is determined by a blow or a fall in which the force is applied to, or the weight of the body received upon, the last phalanx while the latter is in a state of flexion, thus impelling the proximal phalanx backward and upward, and depositing it upon the dorsal surface of the metacarpal bone.

(Fig. 962.)

The ensuing deformity is very striking. The thumb is shortened and twisted inward; the ungual phalanx is flexed by the tension of the tendon of the flexor longus pollicis muscle; the proximal phalanx is fixed, and two prominences are seen at the metacarpo-phalangeal joint. The one on the posterior and outer surface of the metacarpal bone is the larger of the two, and is the head of the proximal phalanx, while the smaller prominence on the anterior or palmar surface of the thumb is the distal end of the metacarpal bone.

(Fig. 963.)

The difficulties which have attended the reduction of this dislocation render it necessary briefly to consider its pathology. Hey supposed that the chief obstacle to the reposition was the entanglement of the displaced phalanx between the lateral ligaments of the joint. And such was Dupuytren's opinion. The explanation given by Mr. Laurie* locates the difficulty in the anterior ligament, which, with the sesamoid nodules, is carried back with the proximal phalanx and lodged between the articulating surface of the latter and that of the metacarpal bone. The same view was entertained by M. Paillaux.†

Others, as Ballingall and Fabbri, believe that the explanation must be sought for in the manner in which the neck of the metacarpal bone is grasped by the two portions of the short flexor of the thumb. Hamilton is of this last opinion. After producing the luxation on the cadaver and

FIG. 962.



Metacarpo-phalangeal dislocation of the thumb.

FIG. 963.



Deformity resulting from dislocation of the thumb backward.

* London Medical Gazette, 1837, vol. ii.

† Nélaton, E. de Pathol. Chir., t. ii. p. 426; Cooper's Surgical Dictionary, vol. i. p. 549.

then carefully dissecting the thumb, I have no doubt that the last explanation is, in most cases, the correct one.

When this luxation occurs, the anterior and lateral ligaments are necessarily lacerated. Immediately in front of the articulation, and attached to the first phalanx of the thumb, is a remarkably dense structure, formed by the tendinous insertion of the short flexor of the thumb, and the fibrous tissue derived from the ligaments and sesamoid bones. As the short flexor has a

FIG. 964.



Metacarpal bone thrust between the two portions of the short flexor of the thumb.

double origin, its two heads, as they converge to their insertion at the head of the proximal phalanx, leave an interval between. When, therefore, the thumb is luxated backward, it carries with it the short flexor, between the two portions of which is thrust the distal extremity of the metacarpal bone, and it is there held, much after the manner of a button in a button-hole,—a simile which has been very appropriately employed to describe this incarceration. (Fig. 964.)

It will be apparent, from the disposition of the parts, that extension of the thumb made in the usual way would only serve to increase the difficulties of reduction,

by drawing this musculo-tendinous collar more firmly about the neck of the metacarpal bone.

REDUCTION, in accordance with the pathological views just stated, can be accomplished in the following manner, and it must be done not by the exertion of great force, but by a rational manipulation. The surgeon, placing his fingers on the ulnar border of the hand and his thumb on the dorsal surface of the metacarpal bone, presses the latter strongly towards the palm of the

FIG. 965.



Position of the phalanges in Crosby's method.

hand. The object of this is to relax the two portions of the short flexor of the thumb which embrace the neck of the bone. The next step consists in grasping the thumb and raising it first to a perpendicular on the dorsum of the metacarpal bone, and then beyond a perpendicular, until its extremity points towards the wrist. The end of the phalanx by this movement becomes a wedge between the two tendons of the short flexor, and serves to conduct them over the head of the metacarpal bone. If now the finger of an assistant be placed behind the proximal phalanx to prevent its slipping back, and the thumb be brought down to the flexed posture, the reduction will most probably follow.

Professor Crosby's method.—This plan, really an old one, having been practiced by Sir C. Bell and by Gerdy, consists in first raising the phalangeal part of the thumb to a right angle with the metacarpal bone (Fig. 965) and then pressing the proximal phalanx from behind forward.

The details of this procedure are as follows. Let the surgeon, seating himself by the side of the patient, take his hand and place it upon his knee.

Then let him raise the dislocated phalanx to a little beyond a perpendicular with its metacarpal bone. Let him now, with his index fingers in front and his thumbs behind, press the base of the proximal phalanx forward until it glides over the distal extremity of the metacarpal bone. (Fig. 966.)

So very obstinate has been the resistance of this dislocation that it has foiled the efforts of the most distinguished surgeons to reduce it. In one instance the thumb was actually torn off in fruitless attempts to replace the phalanx. Accordingly, many suggestions have been made to overcome the supposed obstacles to replacement.

Sir Charles Bell proposed the subcutaneous division of one of the lateral ligaments. Hamilton succeeded in restoring a case which had successfully resisted other measures, as he believes, by dividing both lateral ligaments. Gibson, Porter, and others have been equally fortunate. This method, however, has failed in the hands of Blandin and others.

It has also been proposed to open the integument behind the dislocated phalanx, and, by introducing a lever, to raise it over the distal extremity of the metacarpal bone.

When it becomes necessary to resort to forcible extension, there are several mechanisms which can be applied to the thumb for that object. Among the most efficient of these are the *double noose*, the *lever-tractor* of Dr. Levis (Fig. 967), and the forceps of Charrière. (Fig. 968.) The last-named has a strap of soft leather stretched between the prongs of each blade, which enables them to retain a firm and painless hold upon the thumb.

Anæsthetics, while they may be given to save pain, possess no value as muscular relaxants in a case of dislocated thumb, the difficulty being a mechanical one.

If, after exhausting the ordinary resources, the surgeon fails to reduce the phalanx, there remains yet another resort, namely, subcutaneous division of the external tendon of the short flexor muscle of the thumb. In a case which was brought into the University Hospital, after other means had failed, the reposition was accomplished in this manner by Dr. Hunter.

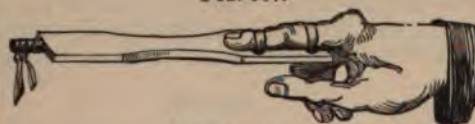
In *old* cases of thumb luxation, the articulation may be excised with advantage, and a movable joint obtained, as was done in one case by Bryant.

FIG. 966.



Manipulation in Crosby's method.

FIG. 967.



Levis's lever-tractor.

FIG. 968.



Charrière's traction and lever forceps.

After reposition of the bone, the thumb must be dressed with care so as to prevent the phalanx from becoming displaced. For this purpose a spica bandage should be applied to the thumb, completing the final turns of the roller by circulars of the metacarpus.

DISLOCATION OF THE FIRST PHALANX OF THE THUMB FORWARD.—This displacement, quite rare, may be produced by having the thumb violently bent backward, or by force applied directly upon the dorsal surface of the bone, as in striking a blow. In this luxation the proximal phalanx is placed in front of the metacarpal bone. (Fig. 969.) The thumb will be shortened.

FIG. 969.



Dislocation of the thumb forward.

There will be a dorsal prominence,—the distal end of the metacarpal bone,—and a palmar prominence,—the posterior extremity of the proximal phalanx. The direction of the thumb may be very little changed from the natural one.

Reduction is effected by first making traction on the phalangeal parts of the thumb, followed by strong flexion. In the event of failure to restore the displaced phalanx to its proper place by

this plan, an opposite one may be adopted, viz., that of forcing the phalanx into a state of extreme extension, and afterwards employing traction.

After reduction, a very light piece of binders' board should be moulded to the palmar surface of the thumb, and secured in place by a narrow roller.

DISLOCATION OF THE SECOND PHALANX OF THE THUMB.—This, the most common of phalangeal luxations, may occur in two directions,—*backward* and *forward*. The relation of the two phalanges in either displacement is too obvious to require comment.

In the backward luxation, which is the more common of the two, the phalanx can be restored by carrying the end of the thumb into a state of *forced extension*; and in the forward luxation, it can be restored by *forced flexion*. A plaster roller or a concave splint, applied to the palmar and lateral surfaces of the thumb, constitutes the best dressing.

Dislocations of the Fingers.

Dislocations of the fingers may take place at the metacarpo-phalangeal and at the phalangeal articulations.

METACARPO-PHALANGEAL DISLOCATION.—The index and the little finger, occupying the most exposed parts of the hand, are generally the subjects of this displacement. The direction of the luxation is most commonly backward, the proximal phalanx being driven upon the dorsal surface of the anterior extremity of the corresponding metacarpal bone. The dislocation backward is generally

FIG. 970.



Anterior metacarpo-phalangeal dislocation.

caused by a blow or fall received on the intermediary articulation.

When the luxation is forward, it is probable that the finger has been forcibly bent backward. (Fig. 970.)

The *signs* of the injury are so palpable as scarcely

to admit of an error being made in recognizing it. And yet I have seen instances of the accident in which the lesion appears to have never been suspected.

If the displacement is backward, there will be seen a hard and prominent projection, made by the posterior extremity of the proximal phalanx, resting on the dorsal surface of the distal end of the corresponding metacarpal bone.

The finger will be shortened, and also fixed, either in the flexed or in the normal position.

The *reduction* may be accomplished by grasping the finger, turning it back into the condition of forcible extension, and then, while making traction, pressing the phalanx forward: usually the digit will then glide into place. (Fig. 971.)

Another method, frequently practiced, is to make extension by the noose, by the lever-tractor of Levis, or by the Indian puzzle.

The *luxation forward* is reduced by making counter-extension from the wrist, and extension from the luxated finger, followed by flexion.



FIG. 971.

Reduction of dislocation of the index finger at the metacarpophalangeal articulation.

Dislocations of the Phalanges.—These luxations are most common at the intermediary articulations, and may be either *complete* or *partial*.

The direction of the displacement which occurs between the *first and second* phalanges is usually backward, and occasionally forward, or lateral. The direction of the displacement between the *second and third* phalanges is either backward or lateral.

These luxations are reduced by extension, counter-extension, and pressure, or by forcible backward extension or flexion, according as the displaced phalanx occupies a position behind or in front of the piece from which it has been separated.

Compound Dislocations of the Thumb and Fingers.

Compound dislocations of the thumb and fingers are not uncommon accidents. Of 34 luxations of the thumb admitted into the Pennsylvania Hospital, 19 were compound; and of 26 dislocations of the fingers, 17 were compound. When attended with much laceration of the soft parts or stretching of the tendons, tetanus is not an unusual sequence.

If the vessels remain intact, the luxated phalanx should be replaced, the wound closed, and the articulation immobilized by placing the finger in a splint moulded to its surface. This should extend over the palmar aspect of the hand to the front of the arm, and be retained in place by a roller bandage.

If the phalanx cannot be replaced with entire ease, or, when restored to position, has a tendency to relaxation, the extremity should be excised before reposition.

DISLOCATIONS OF THE BONES OF THE PELVIS.

The most superficial inspection of the ligamentous pelvis will make it evident that nothing short of an extraordinary force will suffice to disjoin the articulating pieces which enter into its construction. Accordingly, we find that when a displacement does occur it is in almost all cases associated with a pelvic fracture, and with serious injury to the blood-vessels and to the viscera within.

The dislocations of the pelvis which are possible are (1) displacement of the sacrum from the ilium,—*sacro-iliac* luxation,—and (2) displacement of the pubic bones at the symphysis.

These dislocations are *incomplete*.

They are produced by forces which are concentrated directly upon the luxated bone, or which subject the pelvis to severe pressure. Among these

may be mentioned the falling of heavy masses of rock upon the pelvis, the passage of the wheel of a heavily-loaded wagon over the hips, or the compression of the hips between the buffers of railway-cars. A remarkable case of dislocation of the sacrum, without pelvic fracture, has been reported by J. Thoresby Jones, Assistant Surgeon to St. Bartholomew's Hospital, Chat-ham.* A man who had been knocked down by an engine, and who had measurably rallied from the shock attending the accident, died seven hours after the injury. The post-mortem revealed a partial luxation of the sacrum forward from both ilia; but no fracture existed. The external iliac vein on one side, and the ilio-lumbar artery on the other side, were wounded, and a considerable quantity of extravasated blood was found in the recto-vesical pouch.

Dr. Thomas Harris, of Philadelphia, witnessed partial dislocations of the sacro-iliac and pubic symphyses in a woman, which were produced by a blow from the fist of her husband.

SIGNS.—Dislocations of the pubic symphysis or of the sacrum must necessarily be difficult of detection. Preternatural mobility of the bones composing the former, and an unusual prominence of the posterior borders of the ilia, with a helpless state of the extremities, from injury to the sacral nerves, are signs which, if detected, would indicate those lesions. But in most cases the existence of these luxations will be more a matter of inference than of certainty.

When the sacro-iliac junction of one side and the pubic symphysis are separated and displaced, we might expect an elevation of the injured side of the pelvis, with a shortening of the corresponding limb. Gibson† witnessed a case of this luxation, and Professor Chaussier‡ has reported one of the same nature. Professor Gross records a case of pathological separation of the pubes from softening of the interpubic fibro-cartilage in a woman during gestation, which rendered her unable to walk or to turn in bed without severe suffering. After parturition, the solidity of the articulation was slowly regained. A number of similar cases have been observed by Paré, Petit, Boyer, and others.

TREATMENT.—The indications in pelvic luxations are the same as in pelvic fractures, viz., to attend to the state of the bladder by using the catheter when the patient is unable voluntarily to void the urine, to surround the pelvis with a broad bandage, and to prevent as far as possible the evil effects of inflammation.

For the last-mentioned purpose, it is best to envelop the entire pelvis in hot flaxseed-meal poultices. They may be kept warm and moist by covering them with a rubber-cloth, or with oiled silk. Pain must be relieved by opiates.

Should the patient be fortunate enough to recover from the injury, a certain degree of weakness of the walls of the pelvis, accompanied by dull pains, will probably be experienced, and will require the support of a firm bandage about the hips. The use of some of the plasters worn for the relief of muscular and other pains will also be productive of comfort.

Dislocations of the Coccyx.—The coccyx may be luxated from the sacrum *forward or backward*, by external or by internal force. When the coccyx is displaced forward, it is usually due to a blow or a fall upon the cutaneous surface of the bone. When it is displaced backward, it is usually due to the pressure of the fetal head in preternatural labor.

The injury is not only painful at the time of the accident, but it is likely to entail some degree of weakness on the lower extremities, and long-continued neuralgic suffering at the end of the bone.

The dislocation can be satisfactorily diagnosed only by a digital explora-

* British Medical Journal, July 6, 1878.

† Gibson's Surgery, vol. i.

‡ North American Medical and Surgical Journal, No. vii., July, 1827.

tion made through the rectum. The reposition must be effected in the same way,—by making pressure and counter-pressure upon the bone with a finger of one hand introduced into the bowel, and with the fingers of the other hand acting on the outside of the bone.

Rest in the recumbent position, with lotions of laudanum and water, and enforced constipation for eight or ten days, in order to prevent displacement from defecation, constitute the after-treatment.

More or less deformity following the luxation may be anticipated. Should this consist of an anterior displacement, it may seriously interfere with the mechanism of labor. In such an event the excision of the bone would be the only resort.

DISLOCATIONS OF THE BONES OF THE LOWER EXTREMITY.

Dislocations of the bones of the lower extremity comprise, first, luxations of the hip,—*coxo-femoral*; secondly, luxations of the knee,—*tibio-femoral*; thirdly, luxations of the ankle,—*tibio-tarsal*; fourthly, luxations of the fibula,—*peroneo-tibial*; and, fifthly, luxations of the foot.

Dislocations of the Hip or Thigh.

Dislocations of the thigh, though stated to be second in order of frequency, according to the statistics of the Pennsylvania Hospital come third. Of 912 cases of luxations admitted into this hospital, 89 were femoral. Of these 89 cases, 78 were males and 11 females; 39 occurred between fifteen and twenty-five years of age; 26 between twenty-five and thirty; 12 between thirty-five and forty-five; 6 between forty-five and fifty-five; 5 between fifty-five and sixty-five; and 1 between sixty-five and seventy-five. The infrequency of this accident in the aged is to be attributed to changes in the structure of the bones, rendering them more fragile, and also to an increasing rigidity in the ligaments and muscles, in consequence of which the elasticity and flexibility of the body belonging to adolescent and adult life are measurably lost, thus predisposing the bones of the skeleton to fracture rather than to luxation. The youngest cases of dislocation of the femur of which I have any knowledge are one recorded by Mr. Powdrell,* occurring in a child six months old, in which the head of the bone occupied the foramen thyroideum, and one, of the same age, reported by Dr. Fanning, of Catskill, New York, to Professor Hamilton. Fanning's case was a girl, and the luxation was on the dorsum ilii. Mr. Kirby, in the "Dublin Medical Press," and Dr. Buchanan, in the "London Medico-Chirurgical Review,"† have each recorded a case of this luxation in a child three years old. In the first the head of the femur was on the dorsum ilii; in the second it was in the ischiatic notch. Few examples of femoral dislocation are met with after fifty years of age. Malgaigne notices five between sixty-five and eighty. Hamilton gives a case of Dr. Kline, of Portsmouth, Ohio, in which the patient, a woman, met with a luxation of the femur at seventy-three. And I find on the records of the Pennsylvania Hospital 5 such cases between seventy-five and eighty-five years of age. Professor Gibson met with a case in which both femurs were simultaneously dislocated, and Dr. Packard witnessed a similar one. One bone was dislocated on the dorsum ilii, and the other into the thyroid foramen.

VARIETIES OF DISLOCATION.—The head of the femur may occupy almost any situation on the innominate bone. But for all practical purposes coxo-femoral luxations can be studied under three forms. These are (1st) the *ilio-ischiatic*, of which there are two varieties, viz., *a*, upward and backward on the dorsum ilii (*iliac luxation*); *b*, upward and backward into the ischiatic foramen (*ischiatic luxation*); (2d) *forward and downward* into the obturator

* *Lancet*, May 16, 1868.

† Hamilton's *Treatise on Fractures and Dislocations*, 5th edition, p. 673.

foramen (*obturator luxation*); and (3d) *upward and forward* on the pubis (*pubic luxations*).

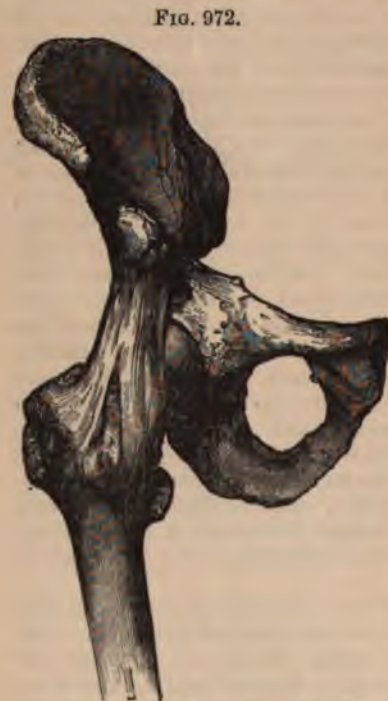
Deviations from these cardinal forms frequently exist. For example, the head of the femur may rest posteriorly on the shelving ridge which forms the outer wall of the acetabulum, or at any point between this and the semi-circular line on the dorsum ilii. Or it may be found at any point within a region extending from the top of the great sacro-ischiatic foramen down to the tuber ischii, below the acetabulum. On the upper and anterior aspects of the acetabulum the head of the bone may be found in the grooves external or internal to the ilio-pubic eminence; and, again, on any part of that surface which extends from the horizontal ramus of the pubes over the thyroid membrane, and to the tuber ischii below.

RELATIVE FREQUENCY.—The most common dislocation is that on the dorsum ilii. Professor Hamilton has given the analysis of 104 hip dislocations, with the following result. There were 55 on the dorsum of the ilium; 28 into the great ischiatic notch; 13 upon the thyroid foramen; and 8 upon the pubis. Bryant states that out of 54 cases, treated at Guy's Hospital and in his private practice, 27 were on the dorsum of the ilium, 12 into the thyroid foramen, 8 into the sciatic notch, and 7 on the pubis.

DIFFICULTIES OF REDUCTION.—There has been considerable diversity of opinion in regard to the obstacles which resist reduction of the femur. It was the opinion of Sir Astley Cooper and others that the chief difficulty consisted in muscular resistance, though these writers were not agreed as to what muscles were most concerned in opposing reposition. Others believed that the obstruction lay in the insufficient size of the rent made in the capsular ligament; while a third set of authorities attributed the difficulty of reduction partly to muscular and partly to ligamentous resistance.

For a better understanding of this subject, I will state that when the head of the femur is luxated upward and backward, the muscles on the inner aspect of the articulation are placed upon the stretch, and not unfrequently are partially torn. These muscles are the psoas magnus, the iliacus internus, the obturator externus, and the three adductors. Those muscles on the posterior aspect which are rendered tense, and portions of which may also be torn, are the quadratus femoris, the obturator internus, the gemelli, and, in a less degree, the pyramidalis. The three glutei muscles are, from the position of the bone, necessarily relaxed. In the opinion of Reid, the resistance to the reposition lay first in the muscles situated posterior to the joint, and finally in those anterior to it.

In 1858, Dr. Norcum, of South Carolina, made some dissections of the hip-joint, to which he called my attention, and which were conclusive, to our minds, that under a proper manipulation there could be no serious muscular opposition experienced in replacing a luxated thigh-bone. Observations still more decisive* have been made upon the cadaver by Fenner, Gunn, Moore of Rochester, and



Ilio-femoral, or the Y ligament of Bigelow.

Bigelow, in this country, which locate the entire resistance in the untorn

* American Journal of the Medical Sciences, vol. xxv. p. 280.

portion of the capsular ligament. In Von Pitha and Billroth's work on Surgery, similar views are expressed in regard to the mechanism of the ilio-femoral part of this ligament, proving that the subject has not escaped the keen observation of our German brethren.

To Professor Bigelow, of Boston, however, the profession is indebted for an exceedingly thorough and, in a great measure, original exposition of the mechanism of femoral dislocations. This distinguished surgeon designated the ilio-femoral thickening of the capsular ligament the Y ligament. This dense mass of fibrous tissue, which serves to reinforce anteriorly the capsular ligament of the hip, consists below of two branches, which have a common origin from the anterior inferior spinous process of the ilium, the external limb being inserted into the outer part of the anterior intertrochanteric line, and the inner limb into the internal portion of the same ridge. (Fig. 972.)

The two branches or layers are connected together by a thinner layer of the capsular ligament. An idea of the strength of the Y ligament may be gathered from the fact that, under the severe tests to which it has been subjected, it is competent, according to Professor Bigelow, to sustain from two hundred and fifty to seven hundred and fifty pounds.

On the integrity or on the rupture of the Y ligament Bigelow founds his classification of coxo-femoral dislocations, namely, into *regular* and *irregular* luxations. The first, or *regular* luxations, are those in which both branches of the Y ligament remain untornd. These are practically the three cardinal forms of the luxation already named. In the second, or *irregular* luxation of Bigelow's classification, both branches of the Y ligament are ruptured, and the head of the bone may occupy almost any position intermediate to the regular ones.

Dislocation Upward and Backward,—Iliac.—In this luxation the head of the femur, after rupturing the posterior part of the capsular ligament and the ligamentum teres, escapes from the acetabulum and is lodged on the dorsum of the ilium, either above or below its inferior semicircular line. (Fig. 973.)

CAUSES.—The excitement attending a dislocation and the instantaneous manner of its production render it very difficult to define the exact state or posture of a limb at the time of the accident. But we are warranted in assuming that, in a luxation of the femur upon the dorsum ilii, the determining force must act on the limb while the latter is in a state of *adduction*, or by causing its violent internal rotation. In either way the pressure of the head of the bone will be brought to bear against the outer aspect of the capsular ligament. Accordingly, it is found that these luxations have been produced by falls upon the knee or the foot at a time when, it is believed, the injured limb was directed across the sound one; or by a crushing weight descending on the back when the pelvis was flexed on the thighs, as when one bends forward; or, finally, by the foot or thigh being caught and fixed while the hips were forcibly twisted.

SYMPTOMS.—When practicable, the patient should always be in the standing position when the examination is made.

The thigh is somewhat flexed and adducted. The knee of the injured limb is a little in front of and a little above the knee of the sound limb. The hip, in consequence of the new position of the trochanter major, is unduly prominent. The foot is strongly inverted (from the resistance of the external branch of the ilio-femoral ligament), the ball of the great toe resting against the inner side of the opposite instep. (Fig. 974.)

When the patient is not too obese or muscular, the head of the femur can be felt in its abnormal position, moving under the fingers when the thigh is rotated. The limb is shortened, the degree of shortening varying from one inch to two and a half inches, depending altogether upon the position occupied by the head of the bone on the dorsum ilii. Flexion and extension

of the injured limb can be made without much resistance; but adduction and abduction, especially the latter, are almost impossible.

DIAGNOSIS.—The only affections of the hip which are likely to be con-

FIG. 974.



Dislocation on the dorsum of the ilium.

FIG. 973.



Dislocation on the dorsum ilii.

founded with this luxation are fracture of the neck of the femur, fracture of the acetabulum, and coxalgia.

From fracture of the neck of the femur the diagnosis may be established as follows:

LUXATION.

Hip very prominent.
Knee adducted and limb flexed.
Foot inverted.
Limb cannot be restored to its proper length by ordinary force; and when restored, it remains so.
No crepitus.
Limb quite immovable.

FRACTURE OF THE NECK.

Hip not prominent.
Knee not adducted, and limb not flexed.
Foot everted.
Limb readily restored to its proper length by extension, but immediately shortens upon the withdrawal of the extending force.
Crepitus.
Limb movable.

In fracture of the neck of the femur with impaction, especially when the foot is inverted, there may be some further difficulty in reaching a satisfactory diagnosis. But if it be remembered that in the latter injury (fracture) adduction, abduction, and rotation can still be made without restriction other than that resulting from the pain consequent on these movements, and if, in addition, the position of the great trochanter, on a level with the acetab-

ulum, be contrasted with the position which this process takes in luxation, behind and above the articulating cavity, there should be no serious difficulty in comprehending the nature of the lesion.

Greater embarrassment will be experienced in distinguishing the luxation under consideration from fracture of the posterior lip of the acetabulum; for in the latter accident the head of the bone is prone to become displaced backward and upward. Here the surgeon will have to reach a diagnosis founded on the marked mobility, the existence of crepitus, and the constant tendency of the bone to escape from its articulating cavity after being reduced,—signs which belong to fractures of the posterior border of the acetabulum.

It might be supposed that no one would be capable of committing so egregious a blunder as to mistake a case of coxalgia for one of dislocation of the femur on the dorsum ilii. Yet Norris mentions an instance of the kind, and I have seen the same error committed in two cases. The age of the child, the flattening of the buttock, the absence of any sufficient injury, the apparent elongation of the limb, the history of a limp in walking, with the eversion of the foot, would be quite sufficient to render such a mistake inexcusable.

Dislocation Upward and Backward,—Ischiatic.—This is sometimes described as the *ilio-sciatic* luxation. It answers to the dislocation into the sacro-sciatic notch of Sir Astley Cooper (Fig. 975), and according to Bigelow,

FIG. 975.



Ischiatic dislocation, or dorsal below the tendon of the obturator internus muscle.

FIG. 976.



Dislocation into the great sciatic notch.

who makes it one of the varieties of a dorsal luxation, it is *dorsal below the tendon of the obturator internus muscle*. The head of the bone may occupy the upper portion of the notch (Fig. 976), or it may be placed across the same, covering to a considerable degree this opening down to the lesser sacro-sciatic ligament.

This dislocation requires for its production a position of the limb at the time of the accident a little different from that which predisposes to the iliac variety; that is to say, when the determining force is applied to the knee, the foot, or the pelvis, the femur must probably approximate a right angle with the body.

The *muscular lesions* which accompany this luxation are by no means uniform. Sometimes the gluteal muscles escape any serious laceration; at other times they are extensively torn. The gemelli and obturator externus muscles may also participate in the laceration.

SYMPTOMS.—The limb is slightly flexed, inverted, and adducted. The knee is turned towards its fellow, touching the thigh at the inner margin of the patella. The limb is rarely shortened more than half an inch, and the shortening may not reach that amount. The extremity of the great toe of the

injured limb touches the metacarpo-phalangeal articulation of the corresponding toe of the sound limb. The hip is less prominent, and the trochanter farther from the anterior superior spinous process of the ilium; the numbness and pain from pressure on the ischial nerve are greater; the bone is less movable, and its head is lower down, than in the iliac variety of the luxation. (Fig. 977.) When the patient is placed in the recumbent position on the back and upon a firm mattress, or on the floor, and an attempt is made to straighten the limb, it is accompanied by a characteristic *arching* of the lumbar part of the back, which disappears when the limb is flexed.

These important symptoms, developed by the alternate tension and relaxation of the psoas magnus and iliacus internus muscles, first noticed by Mr. Syme, are both characteristic and differential, as they do not exist in the order mentioned in any other injury or disease of the hip-joint.

In addition to these means of diagnosis may be mentioned another, given by Dr. Squires, of Elmira, for diagnosing more particularly *old* ischiatic luxations, but which Hamilton has



Ischiatic dislocation.

shown to be not less applicable to more recent ones, viz., a digital examination made through the rectum or the vagina.

Reduction of Iliac and Ischiatic Dislocations.—There are two methods of reducing femoral luxations,—by *manipulation* and by *extension and counter-extension*.

REDUCTION BY MANIPULATION.—The patient, being placed on his back upon a firm mattress, or upon a comfortable or quilt doubled on itself and laid on the floor, should be brought under the influence of an anæsthetic. The surgeon, kneeling by his side, grasps the ankle of the injured limb with one hand, and the front and sides of the knee with the other. The leg is next flexed on the thigh, and the thigh upon the pelvis. After this, the limb is

adducted, carried to the sound side, rotated slightly outward, and finally, by external circumduction, is swept across the abdomen and brought down to the straight position alongside of its fellow. The head of the bone usually glides into the cotyloid cavity with an audible sound at the termination of the circumduction. (Fig. 978.)

FIG. 978.



Reduction of iliac and ischiatic dislocation by flexion, adduction, external rotation, and circumduction.

The mechanism of the reduction is as follows. By flexing the thigh on the pelvis, in the iliac dislocation, the ilio-femoral ligament is relaxed, and the head of the bone is free to move downward towards the outer and lower margin of the acetabulum. In the ischiatic luxation, flexing the thigh on the pelvis serves to disengage the head of the femur from the tendon of the obturator internus muscle. The adduction compels the bone to hug the side of the articulating cavity, and the external rotation and circumduction, by winding the outer branch of the ilio-femoral ligament round the neck of the bone, raises the head of the femur over the acetabulum, on the principle of the windlass or sliding fulcrum. (Fig. 979.) It is possible during the manipulation, especially while making abduction, by using too much force, to lacerate the posterior portion of the capsular ligament to such an extent as to allow the head of the bone too much liberty, in consequence of which it may descend below or even swing round in front of the acetabulum. A case of iliac luxation was sent to the Pennsylvania Hospital, in which a number of fruitless efforts had been made to replace the head of the bone before the admission of the patient, but which had doubtless been thwarted by the laceration just men-

FIG. 979.



The operation of the ilio-femoral ligament in winding the head of the femur towards the acetabulum, on the principle of the windlass.

tioned. On the first attempt to reduce the bone by manipulation, I was satisfied, from the behavior of the limb, that this was the case. The chord of the arc was too long. By placing a sheet around the thigh at a right angle with the limb, and intrusting it to an assistant, who was directed to make outward traction during the external rotation and circumduction of the thigh, the reduction was effected without difficulty.

Not unfrequently the reduction can be made by raising the limb on the hand placed in the popliteal region as a fulcrum during the movements of external rotation and circumduction.

An oscillating movement of the thigh is sometimes practiced with success at the same stage of the process.

REDUCTION BY EXTENSION AND COUNTER-EXTENSION.—Morgan introduced into Guy's Hospital a plan for applying extension and counter-extension in coxo-femoral luxations, very similar in its operation to that practiced by Cooper and others in dislocations of the humerus. A foot was placed between the thighs and against the perineum, to exert counter-extension, while extension and rotation were made by assistants from a band attached to the thigh above the knee. The limb, during the application of these forces, should be carried towards its fellow, making the foot a fulcrum, in order to press the bone off from the pelvis. Cock* succeeded in replacing three dislocations of the thigh in the same hospital, by the same method, one being a luxation on the pubic bone.

When it becomes necessary to employ greater force, extension can be made by bands attached above or below the knee. The former position is to be preferred, as by leaving the leg free it can be used as a lever to aid in the reduction.

This method is the one generally adopted by English and American surgeons. Gerdy increased his points of extension by including both the thigh and the leg in his extending bands.

Counter-extension must be applied to the perineum of either the sound or the injured limb. Gibson preferred the former; but practically it is a matter of no importance on which side the band is placed, as the resistance to be encountered is not so much muscular as it is ligamentous and osseous. Consequently, the stimulation of the adductors, by the pressure of the counter-extending band on the perineum of the injured side, is a matter of little importance. A thick compress should be interposed between the perineum and the counter-extending band.

As the pelvis, during extension and counter-extension, is prone to be twisted round, it will become necessary to counteract this tendency by passing a folded sheet transversely about the hips, at a right angle with the counter-extending band, and fastening it to the side of the bed, or intrusting it to an assistant, who, by drawing on the same, maintains the patient in a proper line.

The thigh, during extension and counter-extension, should be somewhat flexed on the abdomen, and the leg bent upon the thigh, the limb being at the same time carried towards its fellow,—a position favorable to the dislodgment of the head of the femur from behind the acetabulum.

Extension to any degree required may be obtained by the use of *pulleys*, first introduced into the surgery of dislocations by Ambrose Paré. The patient should be laid flat upon a low bed having a firm mattress, or upon a strong table, previously covered with a heavy quilt. The counter-extending band must next be passed through the perineum, and its end secured to a foot of the bedstead. A sheet, after being folded into a band, and wet with water, to prevent slipping, should be formed into a reversed noose, slipped over the leg, and tightened around the lower part of the thigh, a short distance above the knee. The ends of the fillet being now tied together form a loop. Into this loop one hook of the pulley is passed, while the other is secured to a staple in a post or wall, at an elevation which will admit of the thigh being flexed while extension is made. (Fig. 980.)

* Guy's Hospital Reports, vol. i. p. 79; Chelius's Surgery, vol. ii. p. 241.

Another sheet must be carried round the pelvis transversely, and given to an assistant, with a view to prevent the obliquity and the descent of the pelvis which would otherwise be caused by the extension.

The arrangements for the reduction are now complete. The surgeon,

FIG. 980.



Reduction of an iliac dislocation by the pulleys.

committing the cord of the pulleys to an assistant, directs the extension to be made in a very gradual manner, until the muscles become wearied, or, as not unfrequently occurs, a portion of the capsular ligament gives way. Then, by rotating the limb outward and carrying it towards the sound side, at the same time suddenly letting go the extension, the head of the bone will probably resume its functional position in the cotyloid cavity with an appreciable slip.

When the dislocation is *ischiatric*, the only modification necessary is to apply the extension with the thigh somewhat more flexed than in the iliac variety. (Fig. 981.)

FIG. 981.



Reduction of an ischiatic dislocation by the pulleys.

In the absence of the pulleys, the Spanish windlass of Gilbert (Fig. 905) may be advantageously substituted.

Whether manipulation or extension and counter-extension be adopted for the reduction, there is a probability that the head of the bone will change its place without entering the acetabulum. The luxation may readily be converted into an ischiatic or even into an obturator luxation, so that the closest scrutiny of the joint is necessary to ascertain that no mistake has been made.

If, upon comparing the two limbs, they are found to be of the same length, the foot of the injured limb being neither inverted nor everted; if the rotation, abduction, and adduction of the latter be free; and if the measurements on both sides between the trochanter major and the anterior superior spinous process of the ilium, and between the trochanter major and the tuberosity of the ischium, are found to correspond, there can remain no doubt as to the certainty of the reduction.

This point determined, the knees of the two limbs should be bandaged together, a towel being interposed to protect the contiguous surfaces. After seven or eight days, gentle movements of the thigh should be made, with a view to prevent stiffness of the joint. In two weeks the patient may be allowed to move about on crutches.

Dislocation of the Head of the Femur Downward and Forward.—This luxation is produced by a sufficient force acting upon the limb while it is in a state of abduction, in which position the head of the femur lacerates the inner and posterior aspects of the capsular ligament, and, passing through it, is lodged over the thyroid foramen upon the obturator externus muscle. (Figs. 982, 983.)

FIG. 982.



Position of the head of the femur in the luxation downward and forward, and its relation to the ilio-femoral ligament.

FIG. 983.



Downward and forward dislocation of the head of the femur.

The accident may occur without rupture of the ligamentum teres, a fact which I ascertained by the dissection of a luxation of this nature. A female patient was once under my care in the Philadelphia Hospital who could produce this dislocation at pleasure.

SYMPTOMS.—The limb is lengthened, rarely more than one inch and a half; it is abducted; it is also in advance of its fellow. The heel is somewhat raised when the body is erect; the toes are generally directed forward, and occasionally are everted. The hip is flattened, and the body inclined forward on the pelvis and towards the injured side. The head of the bone may also be felt below the horizontal ramus of the pubes.

The anatomical explanation of the phenomena present in thyroid dislocations is this. The increased length of the limb follows from the position of the head of the femur, the thyroid foramen being lower than the acetabulum. The abduction is due partly to the tension of the inner branch of the ilio-femoral ligament when this is not torn, but chiefly to that of the glutei, the *psoas magnus*, *iliacus internus*, and external rotator muscles of the hip. The flattened state of the hip results from the elongation of the gluteal muscles; and the forward inclination of the body is an instinctive movement made to relax the *psoas magnus* and *iliacus internus* muscles.

The elongation and rigidity of the limb, together with the absence of crepitus, are sufficient to distinguish this dislocation from fracture at the neck of the femur.

REDUCTION BY MANIPULATION.—Flexing the leg and the thigh, the limb is carried up at a right angle with the pelvis, in a position of abduction, by which the *psoas magnus* and internal iliac muscles and the ilio-femoral ligament are relaxed. The limb is next adducted and rotated inward, by which means the internal branch of the ligament is wound round the neck of the bone, raising the latter towards the acetabulum. Finally, the limb is carried across the abdomen towards the sound side, and brought down in a position of adduction to the side of its fellow. (Fig. 984.)

Reduction is more likely to occur if, at the time the circumduction across the abdomen is being executed, one hand is placed in front of the thigh and the other in front of the knee, the two strongly antagonizing each other, so as to force the femur away from the pelvis, at the same time that it is elevated or lifted upward. This precaution will often prevent the head of the bone from swinging round below the cotyloid cavity and thus converting a thyroid into an ischiatic or even into an iliac luxation.

The same object is attained by passing a fillet beneath the upper part of the thigh and raising the latter at the moment the limb begins to descend. When the head of the bone has glided into the posterior position, I have succeeded in effecting reduction by adopting manipulation for the iliac and ischiatic displacements.

REDUCTION BY THE PULLEYS.—Sir Astley Cooper's plan of using the pulleys in this dislocation was, after placing the patient flat on the back, to pass a strong band upward and outward through the perineum of the dislocated limb, and to fasten the band to a pulley. A second band was carried around the pelvis and given to an assistant stationed on the sound side of the patient.

FIG. 984.



Reduction of an obturator dislocation by manipulation.

The pulleys having been tightened, so as to draw the upper extremity of the femur outward, the surgeon, passing his hand beneath the sound limb,

FIG. 985.



Reduction of an obturator dislocation by the pulleys.

grasped the ankle of the injured one, and, as soon as the bone was felt to move, drew the latter strongly inward. (Fig. 985.)

Dislocation of the Head of the Femur Upward and Forward.—The dislocation of the femur upward and forward usually occurs from falls upon the foot or upon the knee when the thigh is thrown far back behind the perpendicular, or it may be produced by a violent twist of the limb.

In this luxation the head of the bone, after lacerating the anterior and inner aspect of the capsule and rupturing the round ligament, is forced upon the pubes, and takes a position generally internal to the pubic eminence, in front of the horizontal ramus of the pubes (Fig. 986), or, occasionally, external to this ridge, in the muscular groove below the anterior inferior spinous process of the ilium.

The femoral artery and vein are always on the inner side of the bone.

This luxation is extremely rare. I have seen but a single instance of the kind.

SYMPTOMS.—The limb is shortened and abducted, the foot is strongly everted, and the thigh is moderately flexed. The head of the bone can be felt in front of the pubes; the trochanter recedes from the surface so as scarcely to be recognized; and the extremity assumes a rigid and fixed position. (Fig. 987.)

The abduction and eversion of the limb are caused by the tension of the anterior branch of the ilio-femoral ligament and the external rotator muscles.

The differential diagnosis between a fracture of the neck of the femur and this luxation will be established by the following considerations: in fracture there are crepitus, undue mobility, no flexion of the thigh, no abduction, and

the trochanter major is easily distinguished. In pubic dislocation there is

FIG. 986.



Position of the head of the femur in a pubic dislocation.

an entire absence of crepitus, the limb is immovable, and the thigh is flexed and abducted; to which signs may be added the *spherical* form of the tumor in front of the pubes, so unlike the end of a broken bone.

REDUCTION BY MANIPULATION.—

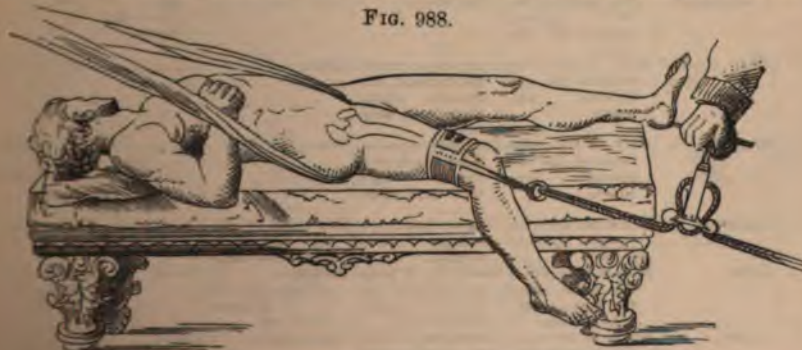
The reduction may be accomplished by almost the same movements as those employed in thyroid dislocations, only modified in the degree of flexion and abduction. The flexion should be to the fullest extent, bringing the thigh into contact with the abdomen. This is done to relax the ilio-femoral ligament, and to dislodge the head of the bone from the pubes, at the same time forcing it in front

FIG. 987.



Position of the limb in dislocation of the pubis.

FIG. 988.



Reduction of the upward or pubic dislocation by extension and counter-extension.

even into the thyroid foramen. Then, after making internal

rotation and adduction, the limb should be brought down inclined to the sound side. In a case of pubic dislocation which had resisted a number of well-applied efforts at reduction, I succeeded in effecting the reposition by these movements.

REDUCTION BY EXTENSION AND COUNTER-EXTENSION.—The manner of applying these forces, as formerly practiced, consisted in attaching the end of the counter-extending perineal band to a hook above and in front of the body of the patient, and in making the extension by the pulleys in a downward direction. (Fig. 988.) As soon as the muscles were wearied and the bone began to yield, a fillet was placed under the upper part of the thigh, and the femur was raised sufficiently to clear the edge of the acetabulum.

Anomalous Dislocations.

Dislocations are occasionally encountered which cannot be properly classed under any of the three general divisions which have been described. To these the name *unusual*, or, more properly, *anomalous luxations*, has been given. Professor Bigelow, in his classification of these injuries, considers none entitled to this distinction except those in which both branches of the ilio-femoral ligament are ruptured. In these cases the head of the bone, being released from all restraint, is left to the uncontrolled force of muscular action. This is no doubt true in many instances, but cannot be so in all. Otherwise we should have a greater uniformity in the symptoms following these different displacements.

These anomalous dislocations may be arranged under three general divisions, namely, **UPWARD** (supra-cotyloid, or above the level of the cotyloid cavity), **DOWNWARD** (infra-cotyloid, or below the level of this cavity), and **FORWARD**, or *subpubic*.

The following table, prepared chiefly from materials gathered from Cooper, Hamilton, and others, will exhibit, in a concise form, most of the recorded cases of anomalous luxation:

Table of Anomalous Dislocations of the Femur.

UPWARD, OR SUPRA-COTYLOID DISLOCATIONS.

No.	Name of Surgeon or Hospital.	Position of the Head of the Bone.	Characteristic Phenomena.	Treatment.	Result.	Reference.
1	Guy's Hospital.	External to the anterior inferior spinous process.	Toes everted and turned quite outward and backward. Abduction.	None.	Died of other injuries.	Lancet, 1840-41, vol. ii. p. 281.
2	M. Wormald (old luxation unreduced).	Between the cotyloid cavity and the anterior inferior spinous process of the ilium.	Slight shortening and abduction of the limb.	None.	Died of pneumonia 17 years after injury.	London Med. Gaz. for 1836-37, p. 658.
3	Mr. Travers (old luxation).	Neck of the bone between the two spinous processes.	Complete eversion; flat buttock; trochanter major high and anterior.	None.	.....	Med.-Chir. Trans., vol. xx. p. 113.
4	Morgan.	Neck of the bone between the two spinous processes.	Complete eversion; flat buttock; trochanter major high and anterior.	None.	.....	Philadelphia Med. Examiner, No. 51, Mütter's paper.
5	Cummins.	Below the anterior superior spinous process.	Three inches shortening; toes everted.	Extension by pulleys and elevation of the thigh.	Cured.	Guy's Hosp. Reports, vol. viii.
6	Lente.	Secondary luxation below the anterior superior spinous process.	Shortening 2 inches, and limb rotated outward very much.	Reduction by pulleys and rotation in different directions.	Cured.	New York Jour. of Med., Nov. 1850, p. 314.
7	Agnew.	Inside of the anterior inferior spinous process.	Shortening 2 inches; eversion and abduction of limb.	Manipulation.	Cured.	

DOWNWARD, OR INFRA-COTYLOID LUXATIONS.

No.	Name of Surgeon or Hospital.	Position of the Head of the Bone.	Characteristic Phenomena.	Treatment.	Result.	Reference.
1	Keate.	On the tuberosity of the ischium; believed to be secondary.	Lengthened over 3 inches; much eversion; thigh strongly flexed.	Reduced, but mode not stated.	Cured.	London Med. Gaz., vol. x., 1832, p. 19.
2	Mr. Gurney, 2 cases.	One a little forward and the other a little backward.	Elongation and eversion of the limb.	Reduced, but mode not stated.	.....	Lancet, vol. i. p. 412.
3	M. Bonisson.	A little backward.	Lengthened 2 inches; flexed, abducted, and rotated outward.	By fracture of the thigh in the flexed position.	Cured.	Gaz. Méd., 1853, p. 664.
4	Kirkbride.	Head of the bone between tuberosity and spine of ischium.	Thigh and leg flexed; knee below its fellow; toes inward, and limb shortened 1 inch.	By pulley extension and lifting the thigh.	.....	American Jour. Med. Sciences, vol. xvi. p. 13.
5	Boux.	Upon inner side of ischium.	Lengthened nearly 2 inches, flexed, and abducted.	Manipulation by flexion, abduction, and outward rotation after direct extension had failed.	Cured.	Rev. Méd. Chir., tom. v. p. 364.
6	J. C. Warren.	In the lesser ischiatric notch.	Limb lengthened, adducted.	No attempt to reduce the luxation, being of 3 months' standing.	.....	New York Med. and Phys. Jour., vol. v. p. 397, 1826.
7, 8	Travers (3 cases of dissection; old cases).	Ischial tuberosity and resting on spine of ischium.	Inversion.	.....	.....	Med.-Chir. Trans., vol. xx. p. 115.
9	Quain (dissection).	Head of femur had passed beneath the sciatic nerve.	.....	.....	.....	Med.-Chir. Trans., vol. xxxi., 1848, p. 337.
10	Mr. Wormald (dissection).	Ischial tuberosity.	Shortened and inverted; femur crossed the symphysis pubis, and fixed.	.....	.....	London Med. Gaz., vol. xix., 1837, p. 557.
11	Mr. Luke.	On tuberosity of ischium.	Lengthened 1 inch; toes neither everted nor inverted, but adducted.	Manipulation.	Death from other injuries.	Med. News and Library, vol. xv. p. 34, from Med. Times and Gaz., Jan. 2, 1838.
12	Blackman, of Cincinnati.	Directly downward.	.....	Manipulation.	.....	Hamilton on Fractures and Dislocations, 5th edit., p. 725.

FORWARD, SUBPUBIC, OR PERINEAL DISLOCATIONS.

No.	Name of Surgeon or Hospital.	Position of the Head of the Bone.	Characteristic Phenomena.	Treatment.	Result.	Reference.
1	Pope.	Behind the scrotum, underneath the raphe.	Thigh adducted to a right angle with the body; retention of urine.	Pulley extension.	Cured.	New York Jour. of Med., March, 1852, p. 198.
2	Parker.	Behind the scrotum.	Thigh adducted to a right angle with the body.	Extension downward and outward; brought the head of the bone into the thyroid foramen; thence to the acetabulum by carrying the luxated limb across the sound one.	Cured.	N. Y. Med. Gaz., 1841.

FORWARD, SUBPUBIC, OR PERINEAL DISLOCATIONS—(Continued).

No.	Name of Surgeon or Hospital.	Position of the Head of the Bone.	Characteristic Phenomena.	Treatment.	Result.	Reference.
3	M. d'Amblard.	Behind the scrotum.	Limb directed outward; retention of urine.	Extension downward and outward; brought the head of the bone into the thyroid foramen; thence to the acetabulum by carrying the luxated limb across the sound one.	Cured.	Malgaigne, t. ii. p. 870.
4	Hodder.	Under arch of pubes.	Thigh at almost a right angle with body.	Extension downward and outward; brought the head of the bone into the thyroid foramen; thence to the acetabulum by carrying the luxated limb across the sound one.	Cured.	British American Journal, 1861.

In the supra-cotyloid dislocations, the predominant characteristics were strong eversion, variable shortening, and abduction of the limb. When the shortening has been observed, it must, doubtless, be referred to an induced obliquity of the pelvis.

In the infra-cotyloid dislocations, eversion, abduction, and elongation constitute the leading signs. But when the head of the bone is a little posterior or near to the spine of the ischium, inversion and adduction are sometimes noticed.

In the subpubic or perineal luxations, the distinguishing feature is an almost rectangular position of the limb with the body.

Partial or Incomplete Luxations of the Hip.

We are not at present in possession of any facts which can be considered as conclusive on the subject of incomplete luxations of the hip-joint. Malgaigne clearly recognizes such displacements; he did not deem a laceration of the capsule necessary for the production of partial luxations, only insisting on the necessity of the head of the bone resting on the margin of the acetabulum. Professor Hamilton would confine these partial luxations to those cases in which the bone does not completely clear the margin of the acetabulum, but rests on the cotyloid notch, after breaking down the transverse ligament; he has reported two cases, and Warren, of Boston, one, answering to this condition. The limb in each case was forcibly abducted and rotated outward, the head of the bone being distinctly felt anterior to the acetabulum. The patients were young.

One luxation was replaced by the father of the boy; the other two remained unreduced.

It is not improbable that in a feeble state of the general health, especially in strumous children, the muscles about the hip-joint may become relaxed and the capsular ligament elongated, as is sometimes witnessed at the scapulo-humeral articulation, and thus may allow the head of the femur to be displaced by a movement or force not sufficiently great to rupture the capsule; or the instances of the injury just noticed may have been pathological rather than traumatic. In other words, they may have arisen from arrested coxalgia, as suggested by Hamilton. At all events, until dissection has removed the obscurity which overhangs this subject, everything connected with it must be mere conjecture.

Complications of Hip Luxation.

Occasionally the force which dislocates the femur, by impelling the head of the bone against the side of the acetabulum, at the same time breaks away a portion of the edge of the articulating cavity, so that the bone, when reduced, is constantly disposed to relaxation. When, after a dislocation of the femur and its reposition, this tendency in the head of the bone to escape from the cotyloid cavity is observed, it may be inferred that a fracture of this kind exists.

The *treatment* of such an injury will consist in discovering, by different inclinations of the thigh, where the complicating lesion is situated, and then in maintaining the limb in a direction opposite to that which causes the displacement until nature has repaired the damage.

Another complication of dislocation is fracture of the femur. The accident is a rare one, and will be indicated by preternatural mobility of the limb, the movements at the same time not affecting the head of the bone.

Two plans of *treatment* are open to the surgeon's choice.

First, he may make an effort to reduce the dislocated head of the bone by properly-directed pressure, and, if successful in this, afterwards to set the fracture. Mr. Birkett, in 1860, Bryant states, reduced with the greatest facility the head of the femur in a dislocation on the ramus of the pubes, in which the bone was broken, in a boy twelve years old. Other instances of a similar complication have been recorded by Bloxam, M. Etève, Markoe, and others.

When the luxation cannot be reduced, the fracture should be set so as to secure the best approximation of the fragments in their abnormal position, hoping that after consolidation has taken place and the continuity of the femur has been re-established, the head of the bone may be restored to its articulating cavity.

Sir Astley Cooper mentions a case in which this was accomplished by extension and counter-extension, five weeks after the injury, in a lad seventeen years of age.

OLD DISLOCATIONS OF THE HIP-JOINT.—The exact length of time which should elapse after a dislocation before it becomes improper to attempt reduction cannot be definitely determined. Sir Astley Cooper fixed the period at eight weeks; and to this opinion surgeons generally assent.

The conditions which may be regarded as unfavorable to reduction are the following:

First, immobility of the head of the bone.—When it is found firmly fixed in its position and but little affected by force applied to the thigh or the leg, it is an evidence that the adhesions are strong and well matured, and also that the inflammation that followed the injury was of a severe nature.

Second, the position of the bone.—An old ischiatic or an obturator luxation will be less amenable to treatment than either a pubic or an iliac luxation.

Third, the condition of the articulating cavity.—When the head of the femur remains for some time out of its socket, both undergo important changes. The head loses its rotundity, becomes atrophied, flattened and roughened, and deprived of its cartilage. The acetabulum becomes shallow, partly by absorption and partly by fibrinous and osseous depositions. These changes take place slowly, but less so in the young than in the aged. I know of no way in which the state of the acetabulum—the more important of the two in its bearings upon this subject—can be fully ascertained. An exploring-needle might be used, but the information acquired in this way could scarcely be deemed trustworthy.

Fourth, when the disability is not very marked.—In many cases of old femoral luxations, the head of the bone has fashioned for itself a new socket; and, while the movements of the limb must necessarily be abridged, the patient is not disqualified from taking exercise, or from following some occupation.

Fifth, feeble health.—A person who is the subject of some serious organic trouble, or whose general health is impaired from any cause, is utterly disqualified to undergo the rude disruption of structures which is necessarily involved in the reduction of an ancient luxation.

There are at least 29 cases recorded of old luxations of the hip which have been reduced at periods varying from six months to five years after the accident.

When it is deemed wise to attempt the restoration of such a luxation, it should be commenced, after the administration of an anæsthetic, by manipulation, and completed, if necessary, by pulleys.

In cases where the head of the bone, by pressing against an important nerve such as the ischiatic or the anterior crural, gives rise to much suffering, or when, in consequence of the malposition of the limb, the patient is rendered peculiarly helpless, and it is deemed improper to resort to forcible efforts at reduction, excision of the head and neck of the bone will be the proper procedure, thus forming a false joint.

Accidents attending Reduction of the Hip-Joint.

The accidents which may attend reduction of a dislocated femur are fracture of the bone, laceration or other injury of the sciatic nerve, and abscess. In one instance, Professor Pancoast, in attempting to reduce a luxation of the hip of three months' standing, fractured the thigh-bone.* The accident, instead of being a calamity, proved to be a decided advantage, as the patient in a few weeks was able to exercise with more facility and comfort than before the fracture. Mr. Hutchinson† narrates a case in which the sciatic nerve was so seriously damaged, in reducing an ischiatic luxation, that permanent paralysis of the muscles endowed by its branches ensued.

Abscesses have formed in the tissues disturbed by the head of the bone when the limb has been subjected to violent movements preparatory to reduction. These have caused extensive disorganization of the soft parts, in consequence of their depth and diffusion. The collection of pus under such circumstances may be predicated upon the presence of pain, swelling, rigors, fever, and sweating. The exploring-needle would aid in the diagnosis; and when the existence of the abscess is established, it should be opened at the earliest moment and the purulent matter evacuated.

Congenital Dislocations of the Hip.

Congenital dislocations of the hip-joint are very rare. They were first studied by Palletta, afterwards by Delpech, Dupuytren, Guérin, Pravaz, North, and others. Females are more commonly the subjects of this defect than males. Of the 45 cases collected by Dupuytren, 39 were females.

The directions of these luxations are similar to those of cases occurring from ordinary causes, viz., on the dorsum ilii, on the pubes, and over the thyroid foramen. I have no knowledge of an ischiatic congenital dislocation. Congenital dislocations may be bilateral. The most common form is that upon the dorsum ilii.

The defect, in most instances, involves the head of the femur and the pelvic bones. The head and neck may remain undeveloped, the former being small, flat, or even absent, the neck being short, dwarfed, and changed in its direction.

The acetabulum sometimes exists as an irregular, shallow cavity, without cartilage or ligaments, and dotted over with rough nodules of bone. At other times it is absent, or is indicated by an elevation, consisting of a shapeless accumulation of osseous masses.

The synovial membrane may be present, retaining its usual attachments to

* Gross's Surgery, vol. ii. p. 108.

† Medical Times, 1866, Bryant.

the circumference of the rudimental cotyloid cavity, and to the neck of the femur, but greatly elongated. Or it may not exist as a capsule at all. The ligamentum teres becomes lengthened, and after years may disappear. The head of the bone, excluded from the normal acetabulum, forms for itself another, though a very imperfect one, on the dorsum of the ilium. The muscles participate in the vice: those which are not called into action shorten, waste, or undergo fatty degeneration; and those upon which devolves an unusual amount of work become hypertrophied.

The *symptoms* which declare a congenital dislocation or malformation may escape detection until the child begins to make its first essays at standing or walking; and even then, if the defect is bilateral, it may for some time escape observation. The most notable feature, that which will perhaps first attract attention, is the great length of the upper as compared with the inferior parts of the body, and the slender, undeveloped state of the muscles of the lower parts when contrasted with those of the upper extremities. The hips present an unusual breadth, owing to the elevated and prominent position of the great trochanters, the pelvis descending between the femurs. The gait is peculiar. The child moves forward with the chest thrown far back, the loins curved forward, the body rising on the ends of the toes, and alternately swaying from side to side as it advances. When in the recumbent position, the limbs are lengthened, in consequence of the weight of the body being removed from the articulations; and they can be drawn out or pushed up and shortened at pleasure, by alternate traction and upward pressure, without causing the child any uneasiness whatever.

When the luxation is unilateral, it can be recognized by the limp in the gait, the high and prominent position of the trochanter major on the affected side when the child's weight rests on the limb, and, as time advances, by the lateral or compensating curve of the spine.

TREATMENT.—The treatment of a case of congenital luxation of the hip-joint can only be palliative. Something may be done in the way of fixing as much as possible the femora. This is accomplished by encircling the pelvis with a strap, so constructed as to press the great trochanters towards the innominate bones. In two cases of this deformity which came under my care, considerable benefit was derived from such an arrangement.

It has been proposed, by means of deep subcutaneous incisions and a systematic combination of movement and rest, to condense the tissues around the head of the bone, so as to circumscribe its motions. This plan has been practiced, but partakes too much of the nature of a forlorn hope to receive any special commendation.

It will be best, in cases of this defect, to enforce, as much as possible, the sitting posture and cold bathing, and, when the patient is old enough to manage an apparatus, the Darrach wheel-crutch will be found, in walking, to answer an excellent purpose.

DISLOCATIONS OF THE PATELLA.

There are five directions in which the patella may be dislocated, namely, *outward, inward, vertically* (or on its axis), *upward*, and *downward*. These displacements may be either partial or complete. They are all quite uncommon accidents.

Dislocation Outward.—In examining the anatomical peculiarities of the knee, the external dislocation would seem to be the least probable. That part of the trochlear surface furnished by the femur for the play of the patella is high, and the ascent more abrupt on the external than on the internal condyle. There is, however, a peculiarity of the quadriceps extensor cruris muscle, in the tendon of which the patella lies, that explains the greater tendency of the bone to external luxation. The tendo patellæ and the quad-

riceps muscle are attached to the patella at an angle the vertex of which is directed towards the internal condyle. This is very noticeable if, when making a ligamentous preparation of the knee-joint (Fig. 989), the rectus femoris muscle be preserved and examined.

In forcible contractions of the quadriceps muscle, the tendency is to convert the angle into a straight line; in doing so the patella is strongly and rapidly swept across to the outside of the articulation. The mechanical effect is not unlike that which follows the action of the digastric muscle,—rapidity of movement at the expense of power.

When the dislocation is a *partial* one, the inner surface of the patella rests upon the articular surface of the external condyle of the femur (Fig. 990), the ridge of the former lying beyond the articular surface of the latter. The resulting obliquity in the position of the patella turns its external border forward, and turns its internal border into the notch between the condyles.

When the luxation is *complete*, the articular surface of the bone lies against the outer surface of the external condyle, its inner edge presenting itself forward. (Fig. 991.) In both dislocations the synovial sac is ruptured,

FIG. 989.



Angle occupied by the patella between the rectus femoris muscle and the tendo patellæ.

FIG. 990.



Incomplete external dislocation of the patella.

FIG. 991.



Complete external dislocation of the patella.

and some of the fibres of the capsule and of the tendo patellæ are torn. Mr. Mayo mentions a singular instance of luxation, in which the inner border of the patella rested against the outer surface of the external condyle of the femur.

CAUSES.—The most common cause of this luxation is muscular action, exerted when the limb is in certain favoring postures, as in dancing or in leaping, or when the thigh is subjected to a violent outward twist, the leg being at the same time fixed. The bone may also be displaced by direct violence done to the part.

There are certain peculiarities connected with the conformation of the limbs, such as *genu valgus*, or "*knock-knees*," which favor the production of this dislocation. Traumatic injuries to the internal lateral ligaments of the knee-joint, or alteration of their structure from pathological changes, by allowing an inward inclination of the knee, are also predetermining causes.

SYMPTOMS.—The breadth of the knee is increased; the internal condyle becomes unusually prominent; the limb is a little flexed, and the joint fixed. If the luxation is partial, the external border of the patella can be felt projecting anteriorly; if complete, both borders can be recognized, the external posteriorly, and the internal anteriorly, in front of the external con-

dyle. The tension of the quadriceps muscle and of the tendo patellæ on the external side of the limb, and the flatness of the tissues on the internal side, are quite noticeable.

TREATMENT.—The reduction is most conveniently effected by placing the patient on his back, in a semi-recumbent position, after which the surgeon, taking his seat on the edge of the bed, by the side of the injured limb, with his face towards that of the patient, relaxes the quadriceps extensor cruris muscle. This is done by placing the heel of the injured limb upon his shoulder. Then, if the luxation is incomplete, he presses the patella inward with his thumb and fingers; if the luxation is complete, he presses it forward and inward, when the bone will resume its normal position.

Some tenderness and swelling will follow the reduction, but usually these are of transient duration. There are instances, however, in which the accident has been followed by high inflammation of the joint, and even by death, as in the case recorded by Mr. Key, of London, in which suppuration of the articulation supervened.

Dislocation Inward.—The infrequency of this displacement will appear from the fact that not more than four or five cases have been recorded. M. Puteignot has reported a case of complete dislocation of both patellæ inward.*

The causes of the accident are muscular action and direct violence.

The luxation may be *incomplete* or *complete*.

In the first variety, the bone is found resting against the articulating surface of the internal condyle, with its internal edge directed forward. (Fig. 992.) In the second or complete form, the bone is entirely displaced from the articulating face of the condyle, and placed on the inner surface of the latter, its edges facing antero-posteriorly. (Fig. 993.)

TREATMENT.—The surgeon and the patient are to assume relatively the same positions as in the reduction of an external luxation, when the bone is to be pressed outward if the displacement is partial, and forward and outward if it is complete.

Vertical or Axial Dislocation.—This remarkable luxation is of very rare occurrence. Hamilton has been able to collect only twenty-four examples

FIG. 992.



Incomplete dislocation of the patella inward.

FIG. 993.



Complete dislocation of the patella inward.

FIG. 994.



Vertical luxation of the patella.

of the injury. The displacement of the bone may be vertical, or the bone may undergo a semi-revolution on its axis.

* Malgaigne, Treatise on Luxations, p. 919.

In the vertical luxation, one edge of the bone rests in the groove between the condyles of the femur, and the other is directed forward. (Fig. 994.) The bone, according to Malgaigne, may rotate either from within outward or from without inward.

In the second variety, the patella is turned completely over, the surfaces of the bone exchanging places, the cutaneous surface resting on the trochlea of the condyles, and the articular surface being turned towards the skin. It is difficult to understand the mechanism of this dislocation. It probably commences as a lateral displacement.

SYMPTOMS.—The leg is extended. The edge of the patella can be recognized under the skin in front of the knee. The extensor muscles are in a state of tension, and over each condyle there is a marked depression. The pain accompanying the dislocation is very severe.

TREATMENT.—This luxation is often exceedingly difficult of reduction. The resistance is supposed to arise from the firmness with which the bone is held in the groove of the trochlear surface of the femur by the contraction of the quadriceps extensor muscle. I do not think, however, that this is sufficient to explain the difficulty experienced in dislodging the bone from this locality; for, even when the tendon of this muscle has been divided, as was done in two instances, once by Dr. Gazzam, of Pittsburg, and once by Dr. Woolf, the obstacle to the reposition was not overcome. We must therefore look for some other explanation than the one commonly advanced. This, I think, will be found in the existence of a slit made in the fibrous tissue of the capsule, in which the patella is imbedded, and through which the anterior edge of the bone slips at the time luxation occurs.

In reducing the bone, an anæsthetic should be first administered. In order to relax the extensor muscle in front of the limb as much as possible, the thigh must first be flexed on the abdomen. Then, while an assistant is directed to alternately flex and extend the leg, the surgeon, with his thumbs placed on the opposite surfaces of the bone,—the one near to its lower edge and the other near to its upper edge,—makes strong pressure in opposite directions. The reduction will most probably follow.

Another method consists in raising the limb and making rapid and forcible extension of the leg, placing a hand in the ham to serve as a fulcrum. In a case of vertical luxation of the patella occurring in a negro during convulsive attacks, Dr. Boyd, of Thornton, Indiana, attempted reposition and failed. During a recurrence of the convulsions, two weeks later, the dislocation was reduced spontaneously. Malgaigne records a similar case of spontaneous reduction, which took place while the patient was walking.

When the patella makes half a revolution on its axis, its cutaneous surface becomes the *lower* one,—a *complete* dislocation. The articular facets may be distinguished beneath the skin. The reduction must be made by flexing the thigh on the pelvis, extending the leg, and grasping the borders of the bone between the thumb and fingers, dragging it forward at the same time that it is turned or rotated in the direction opposite that of the displacement. During this manipulation the knee should be flexed and extended. It was somewhat after this method that M. Castara* reduced a complete dislocation of the patella.

After the reduction of a dislocated patella, the knee, covered with a cold anodyne lotion, should be placed upon a posterior splint, and kept quiet for eight or ten days. Afterwards gentle movements of the joint may be allowed. As a prudential measure, a flannel roller should be worn around the articulation for several weeks after the patient commences to walk about.

Dislocation Upward.—Upward luxation of the patella can only occur as a result either of pathological elongation or of rupture of the ligamentum patellæ. The luxations of this kind may, therefore, be divided into *pathological* and *traumatic*. Fracture at the apex of the bone has been confounded

* Malgaigne, t. ii. p. 918.

with this injury. The traumatic form may be produced by leaping or falling.

The signs of the dislocation are very much the same as those of fracture, namely, retraction of the patella, flattening of the knee, and inability to extend the leg. But it may be distinguished from fracture by the fact that only a single piece of bone can be detected, whereas in fracture two fragments will be found, one joined to the tendon below the knee and the other to the muscle above the joint.

When the upward luxation is produced by structural changes in the ligament itself, or by disease of the joint, the displacement is a gradual one; when it arises from rupture, it is sudden or immediate.

TREATMENT.—The treatment for traumatic luxation is the same as that for fracture of the patella, namely, moderate elevation of the limb, a posterior splint, and adhesive plasters applied so as to approximate the divided ends of the tendon.

Pathological cases can only be remedied in so far as the diseases which produce them are amenable to treatment.

Dislocation Downward is traumatic in its origin. It can only be caused by violent muscular action, in which the quadriceps extensor cruris is torn immediately above the tendinous capsule of the patella, allowing the bone to descend towards the tibia.

The signs of the accident consist in the existence of a marked depression a short distance above the front of the knee-joint, with two prominences, one below, formed by the patella, and one above, caused by the retraction of the quadriceps muscle. The limb cannot be extended, and the injury is followed by considerable swelling.

The treatment is the same as that directed for upward displacement.

CONGENITAL DISLOCATIONS of the patella have been observed a number of times. The most remarkable cases are those recorded by Dr. Caswell,* of Providence, Rhode Island. Five members of one family, extending over three generations, had double congenital dislocations of the patella.

DISLOCATIONS OF THE KNEE.

The infrequency of this dislocation is the best evidence of the perfection of a mechanism in which, for the fulfillment of its function, it was requisite that the articulation should be so constructed as to harmonize the easy, graceful movements displayed in walking with the possession of great strength. The articular surfaces, accordingly, are extensive, and so arranged that they do not move in parallel planes. Not only are the ligaments very powerful, but they occupy the interior as well as the exterior of the joint, while in front the patella, with its muscle and tendon, gives an additional security to the articulation.

There are four principal luxations of the tibio-femoral joint, namely, *backward*, *forward*, and two *lateral*. These may be partial or complete. There is also a variety of dislocation which may be classed as a luxation by rotation.

Dislocation Forward.—This luxation is generally complete. In a collection of 26 cases made by Malgaigne, only two were incomplete. In this injury, the tibia is carried in front of the femur, the spinous process on the head of the former resting in the notch of the trochlear surface of the femur. Or the tibia may overlap the femur to a much greater degree. (Fig. 995.) A displacement of this nature involves a very extensive and serious laceration of the ligaments and other structures about the joint. The dissections which have been made of this injury have revealed a rupture of one or other of the crucial ligaments, also of the fibrous involucre of the joint, derived from the vasti muscles, together with rupture, partial or complete, of the heads of

* Hamilton on Fractures and Dislocations, 5th edit., p. 822.

the gastrocnemius and biceps flexor cruris muscles. The patella lay in a depression above the head of the tibia. The popliteal vessels and nerve appear to have escaped any serious injury.

The causes which determine this luxation are such as act either on the foot or on the thigh when the joint is in a flexed position. In the one case the bones of the leg are impelled forward, and in the other the femur is forced backward. In whichever way the luxation is produced, there is usually joined to the flexion a torsion or twist of the leg.

FIG. 995.



Anterior dislocation of the leg.

SYMPTOMS.—The leg is shortened from one and a half to three inches, and it may be either extended or slightly flexed, depending on the injury to the gastrocnemius muscle. Two prominences are seen, one in front of the knee, formed by the head of the tibia, and one behind, in the ham, formed by the condyles of the femur. These prominences may be satisfactorily recognized by the touch; in them the outlines of the tuberosities and the condyles of the respective bones can be distinctly traced. The patella may lie either in front of the tibia, or in a depression above the head of the latter. In either case it is quite movable, in consequence of the relaxation of the quadriceps muscle. The leg is generally found rotated in either an outward or an inward direction, according as the biceps muscle does or does not retain its hold upon the head of the fibula.

TREATMENT.—Place the patient upon his back on a hard mattress, and administer ether. Apply a counter-extending band to the thigh, and an extending band to the leg above the ankle, intrusting both to assistants, who are to make steady and strong traction while the surgeon, with his arm or knee underneath the joint, forcibly flexes the leg.

Dislocation Backward.—This dislocation, though not uncommon as a result of disease, is extremely rare as a traumatic injury. The head of the tibia is carried either partially or entirely behind the condyles of the femur. (Fig. 996.)

FIG. 996.



Posterior dislocation of the tibia.

The posterior ligament is lacerated, the heads of the gastrocnemius, popliteus, and quadriceps muscles, together with the popliteal vessels, are placed upon the stretch, and in one case the artery has been torn. In Malgaigne's collection of posterior tibio-femoral luxations,—twelve in number,—six were partial and six complete.

The luxation is produced by a force acting either in front of the leg when the thigh is fixed, or behind the latter when the leg is immovably fixed.

SYMPTOMS.—The leg is shortened and bent forward or extended. A depression exists in front of the joint. The rounded condyles of the femur can be seen and felt anteriorly, and the head of the tibia is found projecting into the ham.

TREATMENT.—The reduction is effected by making extension and counter-extension from the ankle and thigh, as in the former luxation, the surgeon forcing the leg into a state of flexion, with his knee or arm acting in the ham.

When the articular surfaces are not entirely separated, the reposition may be accomplished without the employment of extending and counter-extending forces, by the surgeon raising the thigh, placing his arm behind the joint, and forcibly flexing the leg.

Lateral Dislocations are either *external* or *internal*. They occur with about equal frequency. Although they are met with of all degrees, they are, nevertheless, rarely complete.

In the *inward* dislocation, the head of the tibia is carried inward, so that the internal condyle of the femur rests upon the outer side of the internal articular surface on the head of the tibia, or upon its external articular surface, or upon the ridge separating the two. (Fig. 997.)

The lateral ligament will be torn to a greater or less degree, according to the amount of the displacement. And it is more than probable that the crucial ligaments will participate in the laceration.

When the dislocation is *outward*, the head of the tibia is carried in an external direction, the external condyle of the femur occupying either the inner portion of the outer articular surface of the head of the tibia, or the inner articular surface, or the ridge between the two. (Fig. 998.)

The lateral and crucial ligaments will sustain a damage similar to that caused by the internal displacement. The patella will also be luxated in the same direction.

The lateral luxations require for their production forces which act laterally and simultaneously, in opposite directions, upon the thigh and upon the leg.

SYMPTOMS.—The signs of the lateral displacements are quite obvious. When the luxation is *inward*, the knee-joint will present a marked increase in its transverse diameter. A hard, round tumor—the internal tuberosity of the tibia—will be seen and felt on the inner aspect of the joint, producing a marked fullness with a depression above. On the outer side, an unusual prominence—the external condyle of the femur—will also be noticed, with a depression below. The limb is not shortened, but generally is somewhat twisted on its axis, so that the spine of the tibia does not present antero-posteriorly. This is due more to the resistance of certain untorn portions of the ligaments than to muscular tension.

When the dislocation is *outward*, the same prominences exist on the outer and inner aspects of the articulation as are seen in the inner displacement, the difference being that the fullness witnessed on the inner side of the knee is due to the presence of the internal condyle, and that on the outer side to the external tuberosity of the tibia.

TREATMENT.—These dislocations are reduced without difficulty, requiring only extension and counter-extension, the thigh and the leg being pressed in opposite directions.

In all dislocations of the knee, after the bones have been replaced, the joint should be immobilized, by suspending the limb in a fracture-box, and applying frequently, for the first few days, cold lotions of lead-water and laudanum. If the inflammatory symptoms run high, attended by much swelling, heat, and tenderness of the articulation, they must be moderated by leeches and a purge, followed by the neutral mixture, containing a small amount of morphia.

After subsidence of the inflammation, gentle movements of the joint ought to be practiced, so as to prevent stiffness. Walking cannot be attempted for two or three weeks, and then only with the assistance of crutches.

The articulation will remain weak, stiff, and insecure for a long time, and may never recover its former usefulness.

FIG. 997.

FIG. 998.



External Rotatory Dislocation.—A very unusual dislocation of the bones of the leg is occasionally seen, in which the tuberosities of the tibia fall antero-posteriorly in addition to being displaced externally. In this rare form of luxation the bones of the leg are twisted so that the internal angle of the tibia looks directly forward, and the fibula is directed backward.

FIG. 999.



Relation of the bones of the leg to the femur in an external rotatory luxation.

FIG. 1000.



External rotatory dislocation of the leg. From a cast taken at the Pennsylvania Hospital.

The tuberosities of the tibia are placed antero-posteriorly, the external condyle of the femur resting in the notch between (Fig. 999). A very interesting case of this luxation came under the care of Dr. Levis at the Pennsylvania Hospital. The accident can only occur by the leg being violently twisted while the thigh remains fixed.

SYMPTOMS.—A marked prominence of the patella is seen externally, the internal condyle of the femur is also very prominent, and the inner border of the calf of the leg presents anteriorly. The spine of the tibia can also be felt directed exteriorly instead of anteriorly (Fig. 1000).

TREATMENT.—The reduction is accomplished by making extension from the leg and counter-extension from the thigh, at the same time twisting the leg inter-

nally or in a direction opposite to the displacement. After the reduction the joint should be kept at rest, and the inflammation controlled by cold anodyne lotions. At the end of twelve or fourteen days passive motion must be made in order to prevent undue stiffness. The limb will remain weak for a long time after such an accident.

Displacement of the Semilunar Cartilages.

This singular displacement is due to rupture of the coronary ligament, allowing one of the semilunar cartilages to move forward during the motion of the joint, and to be caught between the femur and the tibia. The internal cartilage is the one generally displaced.

This peculiar derangement of the cartilages was first described by Mr. Hey. It generally occurs suddenly, caused by a twist of the leg when the limb is in a state of flexion, and is accompanied by pain and inability to extend the leg. The true nature of the injury is frequently overlooked. In one instance a young man was brought to me from a neighboring State, who, four weeks previously, while on his knees, suddenly experienced a severe pain in the knee-joint, and at once found it impossible to straighten the leg. Various applications had been used to remove the stiffness, which was supposed to be due to a sprain. A few moments enabled me perfectly to restore the functions of the joint. In a second case, a lady, while playing with a kitten on the floor, in a moment found both knees become locked, so that she was unable to regain her footing. She had been some time in this situation when I saw her, but was cured without the least difficulty. In a third and a fourth case, both females, the derangement had followed an accident, in which the patients were thrown from a carriage, several weeks before they came under my observation.

TREATMENT.—When much pain is experienced, it is best to administer an

anæsthetic before attempting reduction. As soon as the patient is rendered insensible, carry the limb first to extreme flexion over the knee, and then suddenly extend it.

Or, if the anæsthetic is not given, the reposition can readily be accomplished by setting the patient at the end of a table, with the leg hanging down. Then, grasping the leg above the ankle, make strong extension, at the same time bending this part of the limb under the table, afterwards bringing it forward to the position of extension.

The reduction may also be secured by flexing the limb round a bed-post, and then extending it.

Very little after-treatment is necessary. In a few days the function of the joint will be restored. But, as there is a tendency to the reproduction of the derangement, the patient should be cautioned to be circumspect with regard to certain movements, especially those of strong flexion. He may also, with advantage, employ a flannel bandage or a laced knee-cap about the knee.

Complicated Dislocations of the Knee.

The complications possible in luxations of the knee are fracture, rupture of the popliteal vessels, and an external wound exposing the joint. Wells, of Columbia, South Carolina, witnessed a case of luxation of the knee in which the internal tuberosity of the tibia was broken. The nature of the injury was disclosed on a post-mortem examination, the patient having died from causes independent of the injury.

A complication of this kind could only be determined by the presence of crepitus and of mobility; and it would require that the detached piece should be pressed into position, should its return not follow the reduction of the bone.

Rupture of the popliteal vessels has occurred in three cases, two of which have been noticed by Mr. Lowe. An accident of this kind will require amputation.

Compound dislocations of the knee-joint are among the most serious accidents which can befall the human body. The complication arises from the presence of an open wound, communicating with a large and complex joint, the inflammation of which exposes the patient to the risks of erysipelas or pyæmia; or, if these are escaped, he is exposed to an exhausting suppuration, or to necrosis of the bones. Whether the antiseptic treatment will, after a more extended trial, modify our views in regard to the management of these cases, remains yet to be determined. Certainly, in the light of our present experience, no injuries more imperatively demand amputation than these.

If the patient is young and possesses a sound constitution, and if, in addition, the blood-vessels have escaped uninjured and the soft parts are not extensively lacerated, resection may be substituted for amputation.

Congenital Dislocations of the Knee-Joint.

Congenital dislocations of this articulation have occasionally been observed affecting sometimes one knee, and at other times both knees. Like the ordinary luxations, they may be complete or incomplete, and may occur in the same directions.

The dislocation forward is said to be the most common.

In some cases, much benefit has followed the application of splints and bandages, after reduction of the displaced bones. The case recorded by Dr. Bard, of Troy, New York, seems to have been cured by this plan, as also one reported by Dr. Youmans.*

When displacement constantly follows the reposition of the luxation, tenotomy may be employed with a favorable result. By this operation

* Hamilton, *Treatise on Fractures and Dislocations*, 5th ed., p. 823.

Hamilton measurably corrected a case of congenital dislocation of both tibiae backward. If the articulating surfaces of the bones forming the joint can, by mechanical measures, be retained in contact for a sufficient time, as the growth of the body advances the injured limb may be rendered but little inferior in usefulness to its fellow.

DISLOCATIONS OF THE FOOT OR ANKLE.

These dislocations are described by Sir Astley Cooper, Malgaigne, and Hamilton as luxations of the bones of the leg. As there can be no reason for departing from the order observed in the classification of the displacements of the other joints, I shall adhere to the nomenclature which I have hitherto preserved in the treatment of this class of injuries, regarding the foot as the part dislocated.

Luxation of the ankle, except as a sequence of a fracture of one or other of the malleoli, is not a common accident. The secure manner in which the astragalus is let in between the malleoli, and the strength of the lateral and posterior ligaments, are inimical to displacement.

Dislocation of the foot may occur in four different directions,—*forward*, *backward*, and *laterally* (*outward* or *inward*).

Dislocation Forward is commonly produced by a violent force acting on the front of the leg when the foot is fixed. Or it may be caused by a fall upon the heel when the tarsus is flexed.

The luxation may be partial or complete. Like the lateral displacements, it is liable to be accompanied by fracture of one or both malleoli. Only four cases have been recorded.

In this dislocation, the lateral and anterior ligaments are ruptured. The astragalus escapes from the mortise-like cavity between the tibia and the

fibula. If the luxation is complete, the tibia rests on the top of the calcaneum. (Fig. 1001.) If the luxation is incomplete, only a portion may lie posterior to the joint. A singular example of incomplete dislocation of the foot is recorded by Mr. Poland, in which the posterior part of the astragalus became wedged between the malleoli so firmly that it could not be reduced.

SYMPTOMS.—The foot is lengthened from one to two inches. The heel is shortened. The malleoli are felt lower down than usual; and the projection of the tendo Achillis disappears, the latter lying



Dislocation of the foot forward.

in contact with the posterior surface of the tibia.

TREATMENT.—To reduce this luxation, the leg must first be flexed to a right angle with the thigh, in order to relax the gastrocnemius and soleus muscles. After this is done, extension should be made from the foot, and counter-extension from the knee, the surgeon drawing the bones of the leg forward at the same time that he forces the foot backward.

When more than ordinary opposition is encountered, the reduction may be facilitated by the administration of an anæsthetic, or by the subcutaneous division of the tendo Achillis.

In an old case of forward dislocation of the foot which I once witnessed, the disability entailed by the malposition of the bones was not very marked, though the motions of the ankle were considerably abridged.

After the bones have been replaced, a fracture-box, or lateral splints, embracing the foot, ankle, and leg, and secured by a roller, will ordinarily furnish the necessary support.

Dislocation Backward is produced by the backward propulsion of the foot while it is in the extended position. The accident is more readily produced if at the same time a counter-force is in operation against the posterior part of the leg.

When the luxation is complete, the lateral and anterior ligaments of the ankle are torn, and the bones of the leg are placed in front of the astragalus (Fig. 1002), the tibia resting in contact with the scaphoid bone; when the luxation is incomplete, it rests upon the neck or head of the astragalus.

The luxation is generally accompanied by a fracture of the fibula and the malleolus of the tibia. Several dissections have been made to establish the existence of this complication. Sir Astley Cooper mentions two,—one by Mr. Tyrrel and the other by Mr. Douglass,—in both of which the lower end of the fibula was broken. Mr. Adams details the lesions observed in another case, in which, in addition to the fracture of the fibula, the malleolus of the tibia was broken.

SYMPTOMS.—The signs of this injury are quite characteristic. The foot is shortened; the heel lengthened and elevated; and the toes, by the contraction of the muscles of the calf of the leg, are turned down. The tendo Achillis, being carried back with the heel, stands off very prominently from the posterior part of the leg.

TREATMENT.—The measures adopted for reduction of the forward dislocation are equally efficacious here, namely, flexing the leg to a right angle with the thigh, and making extension from the foot and counter-extension from the knee, while the bones of the leg and the foot are forced by the surgeon's hands in opposite directions.

This dislocation is generally more difficult to reduce than the one forward, and sometimes manifests a great disposition to relaxation. When this is the case, the division of the tendo Achillis constitutes the best remedy, and should always be adopted. In a case of this dislocation which showed a tendency to recur, I was enabled to resist the displacement by applying a weight to the front of the leg for a short time.

After the reduction, the limb should be placed in a fracture-box and suspended. If this dressing proves unsatisfactory, the apposition of the bones can be maintained with greater certainty by applying to the ankle a plaster roller, which, when it becomes hardened, constitutes a secure case for the joint. But the precaution must always be taken to observe that the dressing does not become too tight from swelling.

If the inflammation following the injury be very marked, it may be necessary to apply leeches and anodyne lotions over the joint.

Dislocation Outward is caused by any violence which forces the foot into a state of extreme abduction, in which position, the internal lateral ligament being ruptured, the astragalus impinges against the external malleolus with such force as to cause a fracture a short distance above this process (Pott's fracture). (Fig. 1003.) In some instances, if the internal lateral ligament does not yield, the astragalus acts the part of a fulcrum, and the extremity of the internal malleolus is likewise broken off. Several times have I seen compound outward dislocations of the foot.

SYMPTOMS.—The signs of this accident are quite apparent. There is an unusual projection of the internal malleolus, beneath which may be felt the tibial surface of the astragalus. The foot is very much everted, its inner surface resting upon the ground and its outer surface directed upward, while,

FIG. 1002.



Dislocation of the foot backward.

two or three inches above the outer malleolus, an indentation may be discovered, which marks the seat of the fracture of the fibula. (Fig. 1004.)

TREATMENT.—The plan of treatment is the same as that employed in the management of a case of Pott's fracture; that is, after bringing the foot

FIG. 1004.

FIG. 1003.



Fracture at the lower fifth of the fibula, with the attendant deformity,—Pott's fracture.



Dislocation of the foot outward, with fracture of the fibula.

into a state of adduction, to apply along the inner side of the leg a splint which will extend from a little below the knee to three inches beyond the foot. A wedge-shaped pad is attached to the splint three inches above its lower end, with its base downward, and so applied that it will rest against the inner ankle. The upper end of the splint is secured to the leg, above the calf, by a few turns of the bandage. The foot is then fastened at the lower end by a figure-of-eight roller of the ankle. (See Pott's fracture.)

Dislocation Inward.—This luxation is by no means so common as that outward; and when it does occur it is generally marked by severe concomitant injuries, such as fracture of the fibula, contusions, and often an external wound. Of 22 dislocations of this kind analyzed by Malgaigne, 19 were compound.

The causes producing this luxation are such as forcibly adduct or invert the foot,—*e.g.*, falls sustained upon its outer border, during which the external lateral ligament is torn and the astragalus rotated outward. It appears that in this luxation, according to Malgaigne, fracture is not so common as in the outward dislocation. In the 22 cases collected by this writer, 8 were unattended by fracture of either the tibia or the fibula; 4 were accompanied by fracture of the fibula; 2 by fracture of the tibia; and in 1 the astragalus was broken.

SYMPTOMS.—The foot is inverted, its outer border resting on the ground, and the external malleolus projecting beneath the integuments. (Fig. 1005.)

TREATMENT.—The bones are restored to their proper relations by grasping the foot and carrying it outward until it is in a proper line with the bones of the leg, after which the fracture-box will serve to maintain the parts in position.

Sometimes cases are encountered in which considerable difficulty is experienced in effecting the reduction, particularly in those forms of the injury

which partake of the character of a true dislocation, and where it becomes necessary to employ more than ordinary force. In such cases, to insure

FIG. 1005.



Dislocation of the foot inward.

the least resistance from the antagonism of the muscles, and to derive the fullest advantage from traction, the leg must be flexed to a right angle with the thigh. A counter-extending band is placed around the thigh, and an extending band secured to the foot, after the manner of the Barton handkerchief. Extension and counter-extension being made, the surgeon aids the reposition

FIG. 1003.



Dislocation of the astragalus upward.

by making such movements of the foot and applying such pressure as will tend to force the parts into place. The use of an anæsthetic will further contribute to the success of these measures.

When there is a tendency to a recurrence of the displacement, and the fracture-box is found not to answer, the difficulty may be overcome by flexing the leg and placing upon its internal surface an angular splint (vol. i. Fig. 387), which should extend seven or eight inches above the knee, and support likewise the foot.

A very rare form of injury at the ankle-joint is one in which the astragalus is forced upward, separating the tibia and fibula from each other, and lodging in the interspace. This has been designated by Nélaton a *luxation of the foot upward*.

The signs of this displacement are a marked increase of the intermalleolar space, imparting an unusual breadth to the ankle, and a sinking down of the malleoli towards the borders of the foot. (Fig. 1006.) The foot can be freely flexed and extended.

The astragalus is restored to its proper position by extension and counter-extension, after which the tibia and fibula must be bound together, and the limb placed in a fracture-box until the inferior peroneo-tibial ligaments have become reunited.

Compound Dislocations of the Ankle.

These are injuries of great severity and gravity. Compound dislocations

are more commonly met with at the ankle than at any of the other joints. The external wound is generally situated at the inner aspect of the joint.

FIG. 1007.



Compound dislocation of the ankle-joint.

(Fig. 1007.) It is made by the lower extremity of the tibia, this bone not unfrequently projecting through the rent in the soft parts.

TREATMENT.—At one time, amputation was deemed the only proper measure in a case of this nature. A larger experience, however, has shown that in most cases of this injury a more conservative course may be adopted, with a reasonable prospect of saving the limb.

The conditions which will render amputation necessary after a compound luxation of this joint, are a very extensive laceration of the soft parts, a bad state of the constitution, and rupture of the principal blood-vessels. The latter lesion, under any circumstances, will be a sufficient reason for the operation.

When, however, the patient possesses a sound body and the blood-vessels remain uninjured, an effort should always be made to save the limb. When the bones protrude, their ends should be excised; but, if they do not protrude, it is better to allow them to remain undisturbed, since the damage inflicted on the surrounding tissues by a forced dislocation for the purpose of excision will do more harm than can be compensated for by the operation.

The wound may be dressed either antiseptically or by irrigation, its edges having been loosely supported by two or three stitches of silver wire. To secure as perfect immobility as is possible ought to be the chief aim of the surgeon. This can be most conveniently done by suspension, either in a fracture-box or in a wire splint.

FIBULAR OR PERONEO-TIBIAL LUXATIONS.

The fibula may be displaced from the tibia at its upper or its lower extremity. Displacement at the upper extremity is called *superior peroneo-tibial*, and at the lower, *inferior peroneo-tibial* luxation. They are both uncommon injuries.

Dislocation of the Upper Extremity.—This displacement may be *forward* or *backward*. There are five recorded examples of the forward dislocation. Of these, Malgaigne furnishes three, Thompson one, and Hamilton, one. Of the second, or backward dislocation, Dr. Joseph G. Richardson has reported one case,* and Malgaigne one.

The injury may follow either direct force or great muscular exertion. The anterior and posterior peroneo-tibial ligaments are torn, and the head of the bone slips forward or backward, according to the direction in which the dislocating force is received by the bone.

SYMPTOMS.—The movable extremity of the fibula and the tendon of the biceps muscle may be felt out of their proper position, and the limb is unable properly to support the weight of the superincumbent body.

TREATMENT.—To return the fibula to its place, it is necessary first to flex the leg, so as to relax the biceps muscle; and then to press the bone in the proper direction.

To insure the permanence of the reduction, the limb should be maintained in that position which favored the reposition, until the fibula has contracted adhesions sufficiently strong to hold it in place.

There is a relaxation of the ligaments of the superior peroneo-tibial articulation, noticed by surgical writers, which permits an undue movement of the

* American Journal of the Medical Sciences, April, 1863.

extremity of the bone. As this condition is usually associated with a feeble state of the general system, it will be proper to administer tonics; and, with a view to condense the fibrous connection of the two bones, the fibula should be forcibly rubbed against the tibia, so as to excite some inflammatory action. When the disability from the displacement is marked, the limb should be flexed and put at rest for some time.

Dislocation of the Lower Extremity.—The only example of this luxation is one recorded by Nélaton, in which the lower extremity of the fibula was forced backward from its connection with the tibia, leaving the external malleolar surface of the astragalus easily distinguishable. The lower end of the fibula lay along the outer border of the tendo Achillis. The displacement was caused by direct force, and no effort was made to restore it.

In a case of this kind, the foot should be extended, in order to relax the tendons of the peroneus longus and peroneus brevis muscles, and the external malleolus should be pressed directly forward.

DISLOCATIONS OF THE TARSUS.

The dislocations occurring in the bones of the tarsus are the following: first, *dislocations of the astragalus*; second, *subastragaloid*, or *astragalo-calcaneo-scaphoid dislocations*; third, *dislocations of the os calcaneum*; fourth, *dislocations of the scaphoid*; fifth, *dislocations of the cuboid*; and sixth, *dislocations of the cuneiform bone*.

Dislocations of the Astragalus.

These may be partial or complete, simple or compound. The bone may be displaced *forward*, *backward*, or *laterally*; there is also a displacement in which the bone is *twisted* or *rotated* on its axis.

When the astragalus is completely disengaged from its connection with the tibia, the calcaneum, and the scaphoid, it may be impelled forward from its bed with such force as to rupture the soft parts and pass completely through the opening. Norris* mentions a case of this kind which was admitted into the Pennsylvania Hospital, and which resulted fatally from tetanus five days after receiving the injury.

Luxation Forward.—This may be complete or incomplete.

When *complete*, the astragalus is disjoined from the calcaneum and the scaphoid bones, and also removed from the mortise between the tibia and the fibula, taking a position in front of the scaphoid, or even still more forward on the cuneiform bone. This displacement may also be accompanied by a fracture of one or both of the malleoli.

When the dislocation is *incomplete*, the degree of displacement will vary in different cases. It may consist in a separation of the head of the bone from the cavity of the scaphoid and its lodgment upon the latter. Or its connection with the os calcis may also be disturbed, so as to admit of a still greater advance in an anterior direction, yet not sufficient to remove the bone entirely either from the intermalleolar arch or from the calcaneum.

In consequence of these differences in the degree of displacement there is always a want of uniformity in the phenomena presented by forward luxation of the astragalus.

The sign which most conspicuously signalizes the accident is the presence of an unusual and irregularly-shaped prominence in front of the ankle, beneath the skin. As it is almost impossible for the astragalus to be projected directly forward, in consequence of its irregularity of form and the different checks to which it is subjected by its associate bones, it will in most instances be found turned towards either the inner or the outer side of the foot, deviations which will necessarily modify the resulting appearances.

* Contributions to Practical Surgery, p. 155.

When rotated in an external direction, in addition to the projection formed by the astragalus in front of the ankle, and which is particularly prominent, the foot is turned *inward*; the external malleolus is unusually salient, and over the inner border and the sole the skin is wrinkled. (Figs. 1008, 1009.)

FIG. 1008.

FIG. 1009.



Dislocation of the astragalus forward and outward.
A, internal malleolus; B, head of the astragalus.

When the bone is dislocated with an inward inclination or twist, the foot is turned outward, and the internal malleolus becomes markedly prominent. In an old, unreduced luxation of this variety of dislocation, dissected by Professor John Neill, the astragalus was found fractured near its posterior border, and the fragments separated by the tibia, which was wedged in the chasm between.

TREATMENT.—The knee being flexed, so as to avoid the resistance of the gastrocnemius and soleus muscles, extension should be made from the foot and counter-extension from the leg below the knee, the surgeon at the same time pressing the astragalus backward into its proper position.

If the reduction cannot be thus accomplished, and there is reason to believe that the obstacle to success resides in the muscles of the calf, a subcutaneous division of the tendo Achillis should be made. Or, if the resistance can be traced to any other muscle of the leg, the division of its tendon will be indicated. Until these measures have failed, no case ought to be abandoned as incapable of reduction.

Rest in a fracture-box, with lotions of cold water or laudanum and water, will constitute the after-treatment.

Dislocation Backward.—In this displacement, the astragalus escapes posteriorly from the intermalleolar space, and from the os calcis and the scaphoid bone, and is lodged on the upper surface of the posterior part of the os calcaneum, between the tendo Achillis and the tibia. It may be twisted slightly inward, though generally the direction of the bone is directly backward.

This dislocation is produced by force acting upon the anterior part of the ankle, when the tarsus is strongly flexed on the bones of the leg. It is not a common luxation, there being not more than eight or nine recorded cases.

The signs of the dislocation are the presence of a hard, incompressible body above the heel, filling up the space between the tendo Achillis and the tibia, with shortening of the foot, in consequence of the tibia having been thrust somewhat forward.

TREATMENT.—Of the eight recorded cases of this dislocation, only one—admitted to the University Hospital, London—has been reduced. In the single successful case, besides the luxation, there was a fracture of the tibia and fibula,—a circumstance which probably made this exceptional.

Unpromising, however, as have been the attempts to reduce this dislocation,

the surgeon must not be deterred by antecedent failures, but should try every safe measure to effect the reposition.

The knee being flexed, so as to relax the gastrocnemius and soleus muscles, extension and counter-extension should be made, as in the anterior or forward displacement. At the same time, strong pressure should be applied on the bone, so as to compel it, if possible, to re-enter the intermalleolar space.

If these measures do not succeed, the tendo Achillis should be divided, and the efforts to replace the bone should be renewed. In the event of ultimate failure, it does not follow that the luxation remaining unreduced will render the limb useless. On the contrary, in the cases noted by Phillips, Liston, Lizars, and Hamilton, a very excellent use of the limb was recovered.

Irreducible Dislocations of the Astragalus.

When it is found impossible to reduce the astragalus, the bone should be allowed to remain undisturbed, whatever may be its position. The surrounding parts may become tolerant of its presence, and after a time the functions of the foot may be in a great measure regained.

Excision should be resorted to only when the soft parts ulcerate and the bone becomes exposed.

When the dislocation is *compound* (Fig. 1010), it will be better to extract the bone at once.

Subastragaloid Dislocation, so termed by Malgaigne, is a separation of the calcaneum and the scaphoid bone from the astragalus. It has also been described as *astragalo-calcaneo-scaphoid* dislocation. (Fig. 1011.)

In this luxation the astragalus still retains its position in the mortise between the tibia and the fibula. It would seem almost impossible, when considering the position of these bones, the disposition of their articulating surfaces, and the strength and number of their ligaments, that such a dislocation could occur short of a complete disorganization of the foot. And, indeed, such was the general belief of the profession, until examples of the injury were published by Pollock, Adams, Macdonnell, Detmold, and others.*

FIG. 1010.



Compound dislocation of the astragalus.

FIG. 1011.



Subastragaloid luxation.

The displacement may occur in four different directions,—*outward, inward, forward, and backward.*

This luxation may be distinguished from that of the astragalus by the fact

* Medico-Chirurgical Transactions, vol. xlii.

that in the subastragaloid dislocation the astragalus remains in its proper functional position,—which can be ascertained by noticing the distance between the head of the astragalus and the malleoli.

In the outward subastragaloid luxation the foot is inverted; in the inner form of the luxation the foot is everted; and in both forms the astragalus may be outlined in front of the ankle.

Of the two remaining varieties of the dislocation, viz., the backward and the forward, the latter is the more common.

The backward dislocation will be indicated by a shortening of the anterior part of the foot and by an unusual thickness of its medio-tarsal portion. When the luxation is forward, the anterior part of the foot is lengthened.

TREATMENT.—When the displacement is not extreme, and there has been no serious laceration of the soft parts, an effort should be made to save the foot. In order to effect reduction, the leg must be sufficiently bent to insure the relaxation of the muscles of the calf of the leg. This will be necessary whatever may be the direction in which the displacement has occurred. If, now, the bones cannot be pressed by manipulation into place, the tendon of the gastrocnemius muscle must be divided, and another attempt made to accomplish the reposition.

When the dislocation is outward, the tendons of the tibialis anticus and tibialis posticus are dragged tightly, the former over the neck of the astragalus, and the latter against the groove of the tibia; and they may demand tenotomy.

When all attempts to reduce the foot have proved unsuccessful, an expectant plan of treatment must be pursued. Should serious symptoms ensue, the only alternative is to remove the astragalus, or to amputate a portion of the foot.

When the subastragaloid dislocation is *compound*, a Pirogoff or a Syme amputation should be executed without delay.

Unusual Dislocations of the Astragalus.—In rare instances, the astragalus has been known to perform certain very singular freaks. It may be displaced directly upward (Fig. 1006). It may revolve on its axis in such a manner as to lie directly across the foot. It has been known to make the same semi-revolution on its vertical axis, and, at the same time, not to escape from the intermalleolar space. In other instances the bone has turned entirely around, its head presenting to the back of the leg and its posterior surface looking towards the scaphoid bone. Lastly, it has been turned over, in such a manner that its lateral surfaces had become vertical in their position, one resting on the under surface of the tibia and the other on the calcaneum.

Dislocations of the Os Calcis.

A few examples of this dislocation have been recorded. In most of these the luxation has been *outward*, separating the calcaneum from the astragalus above and from the cuboid bone in front.

The characteristic symptoms resulting from the displacement are a distortion of the heel, a projection beneath the outer malleolus, and an inability to abduct or adduct the foot.

The accident may be caused by a fall upon the heel, or by intense pressure applied to the side of the foot.

TREATMENT.—When the luxation is easily recognized, its reduction appears to be attended with no unusual difficulty. In the two cases recorded by Malgaigne, displacement was easily corrected by M. Jourdan, by pressing the calcaneum inward, while an assistant at the same time pulled the leg outward.

A similar success followed in the two cases of Mr. South.* His method of reduction, however, was a little different from that of Jourdan.

In Mr. South's case the leg was flexed upon the thigh, thus relaxing the gastrocnemius, after which extension was made on the foot, by grasping with

* Chelius's Surgery, by South, vol. ii. p. 354.

the two hands the heel and the instep, while strong pressure was exerted on the outside of the bone.

Dislocations of the Scaphoid Bone.

Five cases of this luxation have been collected by surgical writers. They are as follows: one by Burnet,* one by Piedagnel,† one by Walker,‡ one by R. W. Smith,§ and one by Bryant,||—one of Mr. Birkett's cases.

When the displacement is complete, the bone is separated from both the head of the astragalus and the three cuneiform pieces; and it will be recognized by the locality of the prominence.

The prevailing direction of the luxations, I find upon analyzing the five recorded cases, is inward. Four were in this direction, and one upward.

The manipulation required for the reduction of the dislocated scaphoid bone consists in making traction on the metatarsus, and at the same time pressing the bone in a direction opposite to that of the displacement.

Dislocation of the Cuboid Bone, as an independent injury, has not been clearly made out. South mentions a case of partial luxation of this bone, but it was accompanied by a similar luxation of the scaphoid. And, although Piedagnel speaks of dislocation of the cuboid bone in three directions,—upward, inward, and downward,—the statement is not supported by any example of the injury.

The existence, however, of such a luxation, should it be encountered, would not, from the position occupied by the bone, be difficult to recognize.

Dislocation of the Cuneiform Bones.—These bones may be dislocated separately or all together. The internal cuneiform is the one most liable to luxation. Sir Astley Cooper witnessed this accident in two instances. Dr. Velder, of Elmira, New York, has published a case of this luxation. The deformity which was said to follow consisted in a large prominence situated at the inner border of the foot, and somewhat above the level of the other bones. The fact that the apex of the internal cuneiform bone is above the other cuneiform, and has the tendon of the tibialis anticus attached to its inner side, will explain the direction of the displacement. Mr. Luke, of London, reported a case of incomplete dislocation upward of all three of the cuneiform bones; and Mr. Key,¶ one in which the two outer cuneiforms were in part luxated.

To reduce this dislocation, the metatarsal bones must be carried strongly outward, while the ankle is fixed, so as to increase the space between the scaphoid and the metatarsal bone of the great toe. After this is done, the displaced bone should be pressed into its place.

DISLOCATIONS OF THE METATARSUS.

Notwithstanding the secure manner in which the metatarsal bones are interlocked and ligated to the tarsus, they are nevertheless occasionally dislocated. They may be luxated singly or together.

The displacement can occur in four directions,—*upward*, *downward*, and *laterally* (*outward* or *inward*). The first is the most common form it assumes.

Dr. Hitsig** has analyzed 29 cases of different metatarsal luxations, 16 of which were dislocations of the entire metatarsus, and 13 of single bones. Of the 16 examples in which the whole metatarsus was luxated, 11 were displaced in the upward direction.

Dr. R. W. Smith has shown that in cases in which a single metatarsal bone, especially that of the great toe, is dislocated, it is often accompanied by the

* London Medical Gazette, vol. xix., November, 1836.

† Dublin Hospital Gazette, 1855, vol. ii. p. 76.

‡ Bryant's Surgery, p. 744.

§ Medical Examiner, 1851, p. 203.

¶ Guy's Hospital Reports, vol. i., 1836.

** New Sydenham Society's Biennial Retrospect, 1865-66.

tarsal bone with which it is articulated. Thus, in luxation of the first metatarsal bone, the internal cuneiform accompanies it, and is thrust upon the dorsal surface of the scaphoid.

These dislocations are produced either by falls, in which the person lights upon the feet, causing the bones to be driven upward, or by heavy weights striking upon the dorsum or upon the sides of the foot. They are frequently caused by a pinch of the foot when caught between the wheel of a street-car and the flange on the iron rail over which it runs. In one case produced in this way, the tarsal extremity of the first metatarsal bone was driven directly into the centre of the internal cuneiform bone.

SYMPTOMS.—The symptoms indicating luxation of the metatarsus are generally quite characteristic. When dislocation of one or more bones of the metatarsus occurs, shortening of the corresponding toe or toes follows, and the prominences of the latter can be seen and felt. When the entire metatarsus is luxated, the whole foot is foreshortened. In all of these luxations the ankle and heel retain their natural form.

TREATMENT.—The reduction is effected by making traction from the toe or toes answering to the displacement, by means of the fingers or through the medium of a noose, while at the same time the dislocated extremities are pressed in the proper direction. The best-applied efforts will sometimes fail of accomplishing the reposition. In this event, the surgeon's attention should be directed to the control of the inflammatory action which ensues upon the injury. A number of examples have been published in which, though reduction was found impracticable, the patients recovered with useful feet.

When, in addition to the luxation, there are extensive lacerations of the soft parts and comminution of the displaced bone, excision will be imperative. And when several of the metatarsal pieces are dislocated and crushed, amputation through a sound part of the foot will be required.

DISLOCATIONS OF THE TOES.

Dislocations of the phalanges of the toes are much more rare than similar injuries of the fingers. The great toe is the subject of luxation oftener than the others. The proximal phalanges are those generally dislocated.

The displacement, though generally upward, may take place downward, or downward and inward. Sir Astley Cooper witnessed a case in which all the toes, except the great toe, were dislocated from the metatarsal bones; M. Josse has recorded a case of luxation of all the metatarso-phalangeal joints.

Dislocations of the toes are occasioned by blows, twists, extreme flexion, and force applied at the extremity of the last phalanges.

The symptoms indicating this injury are shortening of the toe, and the existence of a prominence, formed by the articular extremity of the displaced phalanx. These luxations are frequently compound.

The reduction is secured by extension, conjoined with properly-directed pressure. Flexion, perhaps extension, may also be demanded before the restoration is completed.

When the great toe has been dislocated, the same difficulties may be encountered as in luxations of the thumb. In four out of ten cases noted by Malgaigne, the reduction could not be accomplished.

Should extension and counter-extension fail to drag the phalanx into place, the surgeon may adopt the method of extreme extension of the toe or its metatarsal bone, with pressure against its dorsal surface.

In all dislocations of the metatarsal and phalangeal bones, after reduction, the parts, being enveloped in a cold anodyne lotion, should be supported in a fracture-box. If there exists a tendency to relaxation, it may become necessary to apply a plantar splint, cut and padded so as to conform to the shape of the foot, to which it must be secured by a roller. A plaster roller may be used for the same purpose.

Compound dislocations of the toes necessitate excision or amputation.

CHAPTER XV.

DISEASES OF THE JOINTS.

Movable Bodies within the Joints.

WITHIN the cavity of an articulation are occasionally found hard, movable bodies, which not only interfere with the movements of the joint, but sometimes cause acute pain and excite inflammation of the synovial membrane.

These bodies were first observed by Ambrose Paré, in the year 1558. He noticed a white, solid mass escape from a knee-joint which he had opened for the purpose of removing therefrom a collection of fluid. The subject seems to have attracted but little attention, as we hear nothing of these bodies again until 1691, when Pechlin describes a case of a similar kind.

The articulations in which these formations are found are the elbow, wrist, temporo-maxillary, and knee. They occur most frequently in the latter. These movable bodies are of two kinds: first, those which appear as small, round, or flat concretions, and which consist of fibrin; second, those which are irregularly round, often nodulated, and formed of ossifying cartilage. They vary in number, in size, and in color. There may be a single one in a joint, or many. Malgaigne met with as many as sixty in the elbow-joint; and Dr. Berry, of Kentucky, extracted thirty-eight from the knee of a negro man. Their size varies from that of a millet-seed to that of a pullet's egg. Their color is sometimes white or whitish-gray; at other times they are of a faint yellow tint. They may be completely isolated from all surrounding connections, or be moored by a filament of fibrin to some point of the synovial membrane. (Fig. 1013.)

Those belonging to the first or *fibrinous* variety originate in different ways. They may be formed out of the flakes or masses of fibrin which float in the transudation attending a synovitis; they may arise in the synovial fluid which has been changed in its constitution by inflammation; or they may form, by condensation of fibrin, around a mass of coagulated blood which has found its way into a joint by the rupture of a vessel. (Fig. 1012.)

Those of the second variety are organized bodies, and are derived from four distinct sources, the first being the synovial fringes. In the apices of these, cartilage-cells are sometimes known to exist, which, under the stimulus of inflammation, undergo active proliferation, thus forming a cartilaginous nodule, which ossifies in the centre. This is subsequently detached by the movements of the joint, and falls loose or free into its cavity. Secondly, one or more of the apices of a synovial tuft may become pinched between, or crowded against, the contiguous surfaces of the bone, giving rise to a localized inflammatory infiltration and thickening, which may subsequently be crushed off from its connection with the synovial membrane and drop into the joint. Thirdly, these bodies may arise outside of the synovial membrane in the periosteum, or in the subsynovial connective tissue, as osteophytes, and be forced into the joint. And fourthly, they may, as Mr. Teale has suggested, be the result of fragmentary exfoliations of the cartilages of the joint. Dr. Adams, of Dublin, believes that they may also have an osteo-arthritic origin.

The presence of one of these movable bodies in a joint is sometimes first recognized after a synovitis followed by hydrarthrosis. In other instances,

nothing which accounts for the existence of the formation can be learned from the history of the articulation.

SYMPTOMS.—The patient, while walking, or in some movement, is suddenly seized with a severe pain, and is unable to move the joint. He becomes sick and faint, and sometimes is compelled to grasp the nearest object to keep himself from falling. In a few moments, if the posture of the limb is changed, the body slips from the articulating end of the bone, the pain instantaneously ceases, and the function of the articulation is immediately restored. At other times, the joint may become locked without involving any acute suffer-

FIG. 1012.



Fibrous concretions found in a joint.

FIG. 1013.



Numerous movable bodies in the elbow-joint; some attached by fine pedicles.—Cruveilhier.

ing,—a circumstance, doubtless, depending on the position of the movable body.

The inconvenience resulting from the presence of these movable bodies will be determined by their mobility, whether entirely detached from the surrounding parts, or restrained by a pedicle. In the latter case the patient may enjoy a long exemption from an articular lock, and then have several attacks in quick succession. It is not improbable that during the quiescent period the cartilage has been either glued by a little inflammatory lymph to some part of the joint, or has fallen into some little recess, formed by the folds of the synovial membrane, by which it has been temporarily fixed; and the return of the symptoms denotive of its presence indicates that it has again been detached or dislodged.

In most cases the new formation can be felt under the quadriceps muscle, on one side of the tendon of the patella, or at the inner side of the joint; and it may even be pushed about by the surgeon's fingers. These indications, taken in connection with the suddenness of the attacks and the severity of the pain, will suffice to establish the true nature of the affection.

In that variety of the disease in which these formations arise from the synovial fluid, or from its intermixture with lymph, the symptoms are by no means so pronounced as when they have an osteo-cartilaginous structure. The only evidence of their existence will be the presence of a moist friction-sound when the patella is pressed upon the condyles, or when the joint is flexed and extended. But, as the same symptom is frequently present in

chronic synovitis, and when no such bodies exist, their recognition is attended with great uncertainty.

TREATMENT.—As long as the patient is capable of moving about without suffering more than an occasional attack, it is best not to interfere, or, at most, not to attempt anything more than palliation. The body has sometimes been directed into a retired part of the joint, where it occasioned no pain, and then fixed by a compress and adhesive straps. This was the plan proposed by Gooch. Mr. Hilton, in addition to thus fixing the cartilage, afterwards locks the knee by a splint, so as to compel the patient to walk with a stiff joint. In some cases, a laced knee-cap will prevent the occurrence of an attack. Nothing answers a better purpose than to apply a plaster roller to the articulation, which, in the case of the knee, while it does not prevent walking, limits the motion of the joint. The inflammation which follows an attack must be treated as an ordinary synovitis,—that is, by rest and antiphlogistics.

Cases, however, will occur in which, from the constant disability of the joint, and oft-recurring inflammatory attacks, it becomes necessary to extract these bodies.

Two operations have been practiced for this purpose,—by *direct incision*, and by *indirect or subcutaneous incision*. The latter, when possible, should always be preferred, as the less dangerous.

When an operation is contemplated, if the patient is suffering from any irritation of the joint, he should be confined to bed for several days; the limb should be kept at rest, and local antiphlogistic remedies applied to the articulation until all signs of inflammatory disturbance have disappeared. If the method by direct incision is selected,—that practiced by Abernethy, Desault, Chelius, and others,—the foreign body must be slid, either by the guidance of the patient or by the fingers of the surgeon, into a favorable situation on one side of the joint,—*e.g.*, in the case of the knee, along the inner side of the patella. The operator then, sliding the superincumbent skin to one side, and fixing the cartilage by a tenaculum, cuts directly down upon the body, and presses it out through the incision, immediately releasing the integument, which, returning to its former situation, destroys the correspondence between the superficial and the deep portions of the incision. This operation, done antiseptically, the wound being neatly closed, dressed, and placed upon a posterior splint, and so retained for eight or ten days, is attended with little danger. The use of the carbolic spray during the operation is unnecessary, the sublimate lotion being preferable.

By the plan of subcutaneous incision,—that devised by Syme and, about the same time, by Goyrand,—there is less danger of air entering the joint. The foreign body must be forced into the most superficial and accessible part of the joint, which is one on the head of the tibia and to the inner side of the tendo patellæ. It may then be fixed, either by the finger, or by a strong needle mounted on a handle and thrust into its substance. The surgeon now introduces a tenotome-knife through the tissues, one-half or three-quarters of an inch below, and carries it obliquely upward until the cartilage is reached, when the blade of the instrument is made to divide freely the surrounding parts. After this, the body must be pressed through the opening into the cellular tissue exterior to the joint, where it may be allowed to remain, or may subsequently be extracted after all risks of inflammation have passed over. In this way, with the greatest ease and without subsequent untoward symptoms, I have removed quite a large cartilage from the knee-joint. The same care in dressing the wound, and the same precautionary measures of rest and cold applications, employed in the former method of treatment, must be observed. When the body is very irregular on its surface, however, this plan will often fail.

When a number of these bodies exist in a joint, it is advised by some surgeons not to attempt too much at a single operation, but to repeat the extractions at considerable intervals of time. In my opinion, however, it is better to make but one operation.

The statistics which have been collected on this subject demonstrate the

subcutaneous to be the safer of the two methods. For example, of the 216 cases collected by Dr. Benndorf, of Leipsic, in which these bodies were removed by direct incision, 143 recovered without complications, 41 perished, and 32 suffered from severe and dangerous symptoms. Of 50 cases operated on by the subcutaneous plan, 28 were cured, 5 died, 5 suffered from severe symptoms, and in 12 the operation was abandoned without being completed. Mr. W. I. Square, of Plymouth, reported to the British Medical Association, in 1871, 24 successful operations by the subcutaneous method. The statistics published by H. Larrey* embody 167 cases, of which 129 were operated upon by the direct incision. Of this last number, 96 were cured, 28 died, and 5 operations failed; while of the 38 cases treated subcutaneously, 19 were cured, 5 died, and 14 failed. Antiseptically done, the mortality would be trifling.

Anatomical Summary of the Components of a Joint.—A joint is composed of the ends of two bones, each covered by a layer of cartilage; and, in addition, in certain joints, such as the knee or the lower jaw, there are between the bones plates of cartilage, called *interarticular cartilages*. The cavity of a joint is lined by a serous membrane (the *synovial*), which penetrates into all the recesses of the articulation, forming *diverticula*, or pouches. In order to amplify the extent of the secreting surface of this membrane, it is also, at certain points, thrown into folds and fringes. The articulation is bound together by strong, inelastic fibrous bands and sacs, called *ligaments*. This mechanism is supplied with blood-vessels and nerves, and is moved by muscles whose tendons are distributed about the articulation, in many instances confined to their places by tubular sheaths or playing over bursæ possessing membranes that secrete a fluid resembling in many respects the synovial fluid. The same nerves which supply the muscles contiguous to a joint furnish branches also to the latter. There are, therefore, comprehended in the idea of a joint, osseous, cartilaginous, serous, and fibrous tissues; and in its pathological changes the part played by the muscles is often such that, in the management of a case of articular disease, they cannot be ignored.

Notwithstanding the articulations are composed of parts apparently so dissimilar, they possess an anatomical unity both in structure and in continuity of parts, the basis of their components being connective tissue. It is, consequently, very difficult to divorce pathologically those which anatomically are one. The influence of this organization upon the morbid phenomena attending disease doubtless had much to do in originating the loose classification adopted by the older surgeons, who were wont to treat all affections of the articulations under the general head of arthritis. For the correction of this error, and for a more rational arrangement of joint diseases, we are chiefly indebted to Sir Benjamin Brodie, who, by careful dissections, succeeded in reducing to order what had previously been a subject of confusion and uncertainty. While it is true that a classification based on anatomical peculiarities of structure is usually a sound one, it is possible that even this may be carried to a degree of refinement, as, I think, has been done by our French brethren, calculated to encumber the subject with needless discussions, destitute of both scientific and clinical value.

I shall make two general divisions of articular affections,—**TRAUMATIC** and **IDIOPATHIC**. Under the first, or *traumatic* division, are included sprains, contusions or concussions, and wounds. The second, or *idiopathic* division, embraces all those diseases which arise from causes resident in the general system, such as rheumatism, gout, syphilis, gonorrhœa, struma, pyæmia, etc.

TRAUMATIC ARTICULAR DISEASES.

Sprains and Contusions, though somewhat different kinds of injuries, as they are followed by similar effects, and as they demand the same mode of treatment, may very properly be considered under one head.

* Gazette des Hôpitaux, No. 67,—Bryant.

SPRAINS.—A sprain is the violent wrenching or twisting of a joint, occasioned by a fall or a blow, in which some of the ligamentous fibres of the articulation are over-strained or torn, and the blood-vessels of the synovial membrane, and, in severe cases, the membrane itself, ruptured. In addition to these lesions, the tendons and their sheaths on the periphery of the articulation are frequently involved in the injury. These accidents are very common, and often, when improperly managed, lay the foundation for serious articular disease.

The joints which suffer most from sprains are the ginglymoid, such, for example, as the ankle, knee, and wrist. In articulations of this class, whose movements are chiefly those of flexion and extension, there is no provision for lateral movements to any extent, and consequently, when an ankle or a knee is violently abducted, adducted, or twisted, the force is concentrated on the lateral ligaments, causing them to give way to a greater or less extent. In the ball-and-socket joints, motion is free in all directions, and the lesions of a sprain cannot occur, except when the movements are carried to an extreme degree.

CONTUSION OR CONCUSSION.—In contusion, the force acts in a manner different from that in a sprain. It is transmitted through the joint, much in the same way as the momentum of a missile, after striking upon the skull, is communicated to the brain or its membranes. The force may act directly, as when a blow is delivered over the surface of a joint, or indirectly, as when the knee-joint is contused by a fall from a height upon the feet. Sometimes one of the elements of a sprain, that of ligamentous tension or rupture, may be conjoined to the concussion, as when the wrist-joint is injured by a blow with the clenched fist. Here, in addition to the direct transmission of force to the joint, the latter is flexed or extended. In severe concussion, besides contusion of the soft parts and of the vessels exterior to the joint, there is laceration of the vessels of the synovial membranes, and frequently of the membrane itself.

In both sprain and concussion, the essence of the disease consists in an excessive hyperæmia of the subserous vessels, followed by traumatic arthritis, which, beginning in the synovial membrane, may extend to the other components of the joint.

SYMPTOMS.—Immediately succeeding a twist or other injury of a joint, there is experienced a severe, sickening pain. If the injury is serious, the articulation is at once rendered helpless, and in a few minutes becomes swollen. A throbbing sensation is experienced in the part, attended by an increase of temperature and severe suffering upon the slightest motion. As the swelling increases, a change takes place in the position of the limb. If the knee or the elbow has suffered, the limb becomes flexed; if the ankle, the foot drops; if the wrist, the position assumed is one of flexion, with adduction. These changes of position are induced by the inflammatory transudation within the joint, and are those which permit of the greatest distention of the synovial sac, with the least amount of tension, as may be proved upon the cadaver by injecting fluid into any of the joints named. This flexion may also be produced by reflex muscular contraction, due to the intra-articular irritation, which is communicated to the flexor muscles of the joint through the agency of the nerves. When the ligaments have been torn, even to a very moderate extent, it will be found that there is an undue lateral movement of the articulation. This can be readily ascertained by grasping the limb above the injured joint and holding it firmly with one hand, while with the other the part below is carried from side to side.

DIAGNOSIS.—The only injury likely to be confounded with sprain or concussion is dislocation. In the former, however, the normal relations of the bony prominences of the joint will be found unchanged, the length of the limb unaltered, and all the movements of the articulation preserved, being only restricted in consequence of the pain attending them.

TREATMENT.—There are three indications to be fulfilled in the treatment

of sprains and contusions. First, to control inflammation; second, to secure the absorption of the transudation; third, to restore the function of the joint.

The first, that of controlling inflammation, is most satisfactorily accomplished by elevating the limb and surrounding the articulation with a wrapping of paper lint, light flannel, or old linen, previously saturated with a cold mixture of laudanum and water,—expedients employed to take advantage of the therapeutic power of gravitation, cold, and local anæsthesia over the force of the blood-stream.

Frequently, hot applications are preferable to cold. The sensations of the patient must determine the choice between the two; and if the tension and throbbing of the joint do not soon begin to subside after the employment of the cold applications, these must be immediately exchanged for the warm. In severe sprains I have generally found the warm applications to yield the greatest comfort. A thick piece of flannel or paper lint, well soaked in hot water to which a little laudanum has been added, should be placed around the injured articulation, and, to preserve the heat and moisture, it should be covered with oiled silk or a rubber cloth.

Decoctions of chamomile or of hops may also be used in the same manner. The effect of the warmth and moisture is to favor transudation, and also to mollify and soften the tissues, thereby unloading the engorged vessels and taking off the pressure from the nerves. These applications must be renewed four or five times during the day.

Twenty-four or thirty-six hours will usually suffice, under the above measures, for the culmination of the acute stage of the congestive or inflammatory factor of the sprain. After this, it becomes necessary to attend to the removal of the transudation which causes the swelling.

To accomplish this end, the hot applications may be laid aside, and slightly stimulating or astringent applications, conjoined with pressure, substituted. A piece of old linen or gauze flannel, after being moistened with soap liniment, dilute alcohol, tincture of arnica, or a solution of common salt in vinegar, should be laid over the joint, and covered in with the turns of a roller applied with sufficient firmness, but so as to cause no pain or uneasiness. Or, what is still more effective, there may be applied to the foot and ankle a plaster or starch bandage, which should remain five or six days undisturbed.

During the entire course of the treatment the most perfect rest of the joint and the position most comfortable to the patient must be insisted upon. This cannot be too strongly enforced.

The third and last indication is to restore the functions of the articulation. After a severe sprain or contusion there often remains, after the subsidence of the inflammation, a certain thickening or plastic infiltration of the connective tissue of the synovial membrane; and not unfrequently this extends also into the surrounding ligaments and sheaths of the tendons, causing rigidity and stiffness of the articulation. This infiltration, in its early history, is very imperfectly organized, and, consequently, can then be quickly removed. To effect its removal, motion is all-important.

I have earnestly enjoined rest in the treatment of sprains and contusions. But rest has its limits. Invaluable at first, or during the acute stage of the injury, after this stage has passed over it becomes a great evil, and I do not hesitate to say that the usefulness of many joints is greatly impaired, and in some cases seriously damaged, by an injudicious persistence in a state of rest. Whenever the inflammatory stage is overpast (which may be determined by the diminution of swelling, sensibility, and heat), the time has arrived to commence motion of the joint. Even when there remain considerable swelling and some undue sensibility, if the thermometer reveals no abnormal elevation of temperature, this motion need not be delayed. The movements to be made are those peculiar to the joint, such as flexion, extension, etc. They must be made by the surgeon or by an instructed attendant, at first very gently and only for a few seconds, two or three times a day, at every repetition increasing the manipulation both in energy and in duration.

If the joint-tissues do not resent these liberties by becoming hot and more swollen, the patient may be allowed to practice this exercise by his own muscles; and after a few days more he may begin to use the joint. If the sprain has been severe and involves the knee or ankle, he may call to his aid, for a short time, a pair of crutches. In order to impart tone to the structures about the joint and to contribute to its protection, the use of a cold-water douche and the application of a flannel band will be desirable. Where the means thus detailed are faithfully employed, it is astonishing how quickly a patient can be got upon his feet and be enabled to resume his usual occupation. Rarely will it be necessary to resort to leeches and purgatives to subdue the inflammation, as advised by many writers. When the ligaments have been extensively torn, it will be a long time before the strength and usefulness of the articulation are regained. While this circumstance does not militate against the employment of movements, it will be necessary to use great caution in the exercise of the limb, as well as to take advantage of artificial appliances to support in part the weight of the body.

Cases will now and then come under the surgeon's observation in which badly-treated or neglected sprains and contusions, either from repeated attacks of acute or from chronic inflammation, occasion considerable structural alterations. The soft parts around the joint are swollen and indurated, and its movements are stiff, restrained, and painful. Sometimes the pain attending these injuries resembles rheumatism; and, being frequently aggravated by certain atmospheric changes, they doubtless do partake somewhat of the nature of this affection.

These are cases which demand the combined operation of blisters, soaking in hot water, *massage*, well-appointed movements, pressure, and the application of the compound solution of iodine over the joint.

Irritable Joint.—There is a peculiar form of joint-trouble which is one of the effects of sprain and of contusion, to which I have given the name of *irritable joint*. It manifests itself several weeks—more commonly several months—after an injury of one of the articulations, most generally that of the knee. The invasion is sudden and unexpected, sometimes occurring by an unaccountable giving way of the joint, at other times without any precedent warning of the kind, while the person is quietly walking on the street, or across the floor. In a few minutes the capsule of the joint is filled with fluid, and the limb becomes almost entirely helpless. Tenderness and even pain are experienced when pressure is made over the internal condyle, and the limb cannot be flexed to the full extent without causing muscular resistance and suffering.

This affection, though most frequently met with in females, is not peculiar to them, but may occur in males also. The suddenness of the attack, the absence of any unusual heat, and the localized sensibility over that part of the articulation which is covered by the branches of the saphenous nerve, all point to a congestive rather than an inflammatory origin, induced most probably by some peculiar state of the articular nerves.

The radical cure of these cases is often very difficult. Rest, blisters, compression, and moderate extension (effected either by a weight suspended from the leg, or by a cord of elastic tubing connected with the foot and fastened to the foot of the bed), together with the use of quinine, iron, and strychnia, constitute the proper remedies. In the course of two or three weeks they usually enable the patient to get about; but they do not so thoroughly eradicate the disease as to confer an immunity against other attacks.

There is another form of irritable joint which demands some notice, and which is a sequence of sprain or of contusion. It may follow soon after recovery from one or other of the above injuries, or it may not appear until several months have elapsed. The joint after being used becomes weary, hot, and somewhat sensitive to pressure. Extreme flexion is painful, and when the joint-surfaces are strongly impelled against each other, a deep-seated

soreness is experienced. Little, if any, swelling is present. But the joint is considered so unreliable that it is with difficulty the patient can be induced to trust himself upon his feet. These symptoms all disappear after a few days of rest, recurring, however, upon the use of the limb.

The *treatment* consists first in the immobilization of the joint, by means of a posterior splint formed of leather and stiffened with thin strips of steel; or a recurrent plaster roller may be used. The plaster splint, which is very easily constructed, answers the purpose admirably. It is formed as follows. First, apply a plain roller to the limb, commencing seven or eight inches below the knee, and terminating about the same distance above. Then, taking a plaster roller, after dipping it in water, carry it transversely back and forth over the first bandage, leaving one inch on the anterior face of the limb uncovered. These recurrences must be repeated until a sufficient number have been made to afford, when dry, the support necessary for the articulation; and, to keep them in close contact with the parts, three or four strips of a narrow roller may be tied around the limb. When the splint hardens, it forms an accurate cast of the limb, and can be sprung open sufficiently to allow of its removal and readjustment without in any way impairing its value.

After having provided for the fixation of the joint, it will be necessary to establish some form of permanent counter-irritation. Although I believe the value of the *actual cautery* is greatly over-estimated in its application to many affections, I am disposed to regard its use with favor in the treatment of the disease under consideration; not that any special virtue resides in the caloric, but simply because the resulting ulcer remains for a considerable time unhealed, and therefore prolongs the counter-irritation. Two or three linear cauterizations may, accordingly, be made with the hot iron over different aspects of the joint. After the slough has dropped, the ulcers should be dressed with the compound resin ointment.

For the first three or four weeks the patient must be confined to bed, after which crutches may be allowed. No attempts at passive movements of the articulation should be made earlier than at the expiration of two months; and on no account should the weight of the body be supported upon the affected side until the lapse of three months. When the patient begins to walk, it must be in a *systematic* manner, first taking a few steps, and every day gradually increasing the exercise by slow degrees, until the accustomed use of the limb has been regained. In this way we may hope to restore the permanent usefulness of the joint.

Wounds of the Joints.

When a wound has penetrated the cavity of a joint it constitutes a serious injury. The complications to be dreaded are both of a *local* and of a *constitutional* nature.

We see here the great difference between subcutaneous, traumatic arthritis, and that which follows an external wound. In the first, there is little tendency to suppuration; in the latter, there is strong probability of such a result. Pus, when confined within the synovial sac, has no way of escape, and is apt to destroy the joint, while the acute symptoms which attend articular suppuration soon give rise to fever and general constitutional disturbance.

The gravity of all penetrating joint-wounds is not the same, though even in the smallest articulations the danger of ankylosis is imminent. It is when the large joints, such as the knee, the ankle, the elbow, and the wrist, are opened that the injury becomes hazardous to the limb, and even to the life of the patient.

SYMPTOMS.—The sign of a wound having penetrated a joint is the presence of a slightly reddish or colorless liquid, having a viscid, sticky, unctuous feel, and which, when rubbed, can be drawn out between the fingers into long threads. Should the puncture or cut have opened a bursa, a similar

discharge will appear,—a circumstance which might lead to an erroneous inference, by creating an impression that a joint has been opened, when such is not the case. When there are sufficient grounds to render the diagnosis uncertain on this point, and only then, a very fine silver probe may be carefully introduced into the wound. The depth to which the instrument extends will resolve all doubts. If the wound is extensive, the patient becomes weak, sick at the stomach, and pale. In those severe lacerations and comminutions of the joints which are produced by machinery and by balls, the most profound collapse is witnessed.

The danger arising from all penetrating articular wounds is due to inflammation of the synovial membrane. All other pathological changes witnessed in extreme cases are dependent upon and secondary to this. These will be treated of under the head of synovitis.

TREATMENT.—The indications to be observed in the treatment of a wound of the joint are the arrest of hemorrhage, the removal of foreign matter, the approximation of the sides of the opening, and the prevention of undue inflammation. Except in military practice, it is not often that any serious bleeding is witnessed in this class of injuries. The vessels on the periphery of an articulation are usually small, and the bleeding ceases spontaneously. Should this not be the case, the vessels must be tied, the animal ligature being preferred for this purpose. After the parts are cleansed, they should be brought carefully and accurately together, either by sutures, adhesive plaster, or strips of silk gauze saturated with collodion. During the cleansing and approximation of the margins of the wound, the parts should be well washed with the sublimate lotion; and after the completion of this part of the dressing they should be covered with the carbolized gauze and sublimated cotton. Finally, the entire limb should be surrounded with a moderately firm roller. In the absence of antiseptic appliances, the wound may be covered with a piece of lint wet with carbolic acid and sweet oil. The crowning part of the dressing, however, without which all else is comparatively valueless, consists in the *absolute immobilization* of the joint. This can be most perfectly accomplished in the case of the knee by the use of a splint made with plaster rollers and prepared antecedent to the operation. The same end can be attained by the use of a posterior trough-shaped felt splint. Whatever mechanism is employed for support, the surgeon will do well to suspend the limb and thereby give perfect security to the parts.

The diet, for the first four or five days, must be restricted, and any feverish excitement which may arise should be combated by a saline laxative, followed by the neutral mixture, to which may be added a little morphine. If everything progresses favorably, in five or six days the sutures may be removed, though the limb must not be taken out of the splint for four or five weeks afterwards, at which time the patient may be considered well.

It is not always, however, that a case progresses in so favorable a manner, particularly if there has been any delay or defect in the plan of treatment. It may happen that after the lapse of a few days the patient begins to complain of pain and uneasiness in the articulation, accompanied with some acceleration of the pulse and undue heat of the skin. If the dressing is opened, the joint will probably be found swollen and very sensitive to the touch, and possibly a little blood-stained synovia may be observed oozing through between the margins of the wound.

These symptoms denote the presence of a traumatic synovitis; and although justly constituting a source of anxiety, this is susceptible of resolution. It is the signal for commencing a vigorous antiphlogistic treatment. For this purpose the local abstraction of blood by leeches and the application of ice-bags to the articulation will become necessary. The latter may be done without the removal of the splint, only requiring that portions over the front and sides of the joint be cut out. If, after a fair trial, the cold fails to give relief, the ice-bags may be removed and the joint covered with a large blister. The pain must be subdued by opiates, and these can be advantage-

ously combined with a mercurial. Half a grain of calomel and the same amount of opium may be administered every hour until relief is experienced, when they may be given at longer intervals. The calomel should be suspended upon the earliest manifestation of the gums becoming affected.

In favorable cases, under these measures, the fever abates, the pain and swelling about the joint gradually subside, and the patient recovers. This is one termination; unfortunately, there may be another. The synovitis may not yield to the treatment; the pain and swelling grow rapidly worse, the temperature rises, the limb becomes œdematous, and the slightest movement of the joint is attended with the most intense suffering, so that the patient dreads the approach of an attendant towards the bed. Accompanying these symptoms will be evening exacerbation of fever, preceded by rigors, and followed frequently by exhausting sweats, an entire inability to take food, and the rapid loss of flesh. As the distention of the joint increases, the limb, unless secured to a proper splint, becomes more and more flexed,—a change of accommodation having both a mechanical and a physiological explanation, already given when treating of sprains.

At this stage of the disease fluctuation may be detected, announcing the formation of pus. But even in this unfavorable aspect of the case there is still ground to hope for a cure.

Whenever, then, fluctuation is discovered, and the synovial sac continues to enlarge, the joint should be opened and the pus evacuated. This operation must not be too long delayed: the presence of pus is very damaging to the joint; and if the synovial membrane once gives way, and the purulent accumulation escapes into the surrounding tissues, the fate of the articulation, in all probability, will be sealed.

After opening the joint, or even when this is not done, the limb must be straightened, so that in the event of ankylosis taking place it shall be in that position which will render it most serviceable. The pain attending the correction of the flexion is so great that the use of an anæsthetic will be necessary.

The purulent fluid having been removed, the subsequent management of the case will consist in washing out the articulation with the sublimate solution, introducing a catgut drain, neatly suturing together the edges of the wound, applying the antiseptic dressings, and continuing the use of the splint. After all signs of active disease have disappeared, it will be proper to venture on making some passive motion, so that the use of the articulation may not be lost.

In still more aggravated cases, the suppuration is not confined within the limits of the synovial sac. The latter either opens by ulceration or is ruptured, allowing the purulent contents to escape into the tissues around; abscesses form at numerous points in the vicinity of the joint; the ligaments and cartilages participate in the inflammation, and the patient, under the exhausting effects of the suppuration, rapidly loses strength, and is liable to perish either from pyæmia or from hectic irritation. In such cases our only hope is ankylosis, excision, or amputation.

To favor the first, the wound in the joint should be freely laid open, so as to furnish a ready exit to the discharges, and to render the cavity of the joint accessible to injections of mercuric chloride, of weak solutions of iodine, or of carbolic acid, with which it should be washed out twice every twenty-four hours. In the same manner the abscesses around the articulation must be opened, and a thorough drainage established, by the use of Chassaignac rubber tubes, or by horsehair or catgut, so as to remove every source of irritation or infection. The limb at the same time should be placed in a proper position on a splint which will admit of no motion, so as to encourage ankylosis.

During this time the general system of the patient must be sustained by generous diet and by the use of tonics and stimulants.

If, notwithstanding every precaution, there is a steady emaciation, accom-

panied with increasing hectic symptoms, it will be advisable not to depend longer on the power of the patient to resist the disease. Otherwise the opportune period for excision or amputation may be lost.

SYNOVITIS.

Inflammation of the synovial membrane of a joint is a very common affection, and arises from both local and constitutional causes. It may be either acute or chronic in its character. No articulation is exempt from the disease, though the large joints, as the knee, the elbow, the wrist, the hip, and the shoulder, suffer most frequently.

Among the local causes may be mentioned wounds, sprains, contusions, cold, and foreign bodies within the joint. When induced by exposure to dampness and cold, the inflammation will usually be of a rheumatic nature. In a large proportion of cases, however, the disease will be found to owe its existence to constitutional causes, such as gout, struma, syphilis, pyæmia; it is not unfrequently due to exanthematous affections.

Sometimes synovitis is primary; at other times it may be secondary to disease in another part of the joint, as in the bone or cartilage. It rarely exists for any great length of time without extending to the other components of the articulation.

Like inflammation of serous membranes in other parts of the body, synovitis is followed by transudation, which may be serous, fibrinous, or purulent. There is, however, some difference between the inflammation of the synovial membrane and that of other membranes of this class. For example, a pleuritis or peritonitis of the mildest kind is generally followed by plastic adhesions, or by formation of pus; but such results, when following a synovitis, are usually evidences of long-continued chronic inflammation.

SYMPTOMS.—Synovitis is sometimes preceded by soreness and stiffness of the articulation, gradually ending in pain over a particular spot,—*e.g.*, one or other of the condyles of the femur, when the knee is the subject of the inflammation. This pain gradually extends until it is experienced throughout the entire articulation. In not a few instances the disease is announced without any precedent discomfort, the patient being suddenly attacked with acute suffering in the joint, any movement of which aggravates the distress. The skin may remain without discoloration, or may present a slight blush and the temperature be notably increased. The pain, after one or several days, is followed by swelling of the joint. On comparing the affected articulation with its fellow, the characteristic depressions which belong to the normal joint are seen to be effaced. The distention of the synovial sac will be greatest in the direction of least resistance,—*e.g.*, in front, under the quadriceps muscle and the patella, when the knee is affected, and posteriorly, beneath the triceps, on each side of the olecranon, when the elbow is the seat of the disease.

Fluctuation, which is one of the signs of synovitis, is modified materially by the nature of the fluid within the joint. When it consists chiefly of serum mixed with the synovia, which is the quality of the fluid in cases of uncomplicated synovitis, the fluctuation is very distinct; it becomes less so in proportion to the amount of fibrin present.

In some cases, any movement of the limb is painful; in others, it can be flexed and extended without causing suffering. If the attack is more acute, as when arising from rheumatism, there may be, in addition to the local signs just enumerated, marked constitutional disturbance, as indicated by a full and frequent pulse, thirst, dry skin, and scanty, high-colored urine, loaded with urates. It is common in this condition of the disease to find the skin over the articulation discolored by a slight blush, tense and glossy, the limb flexed, and the patient complaining of a deep-seated pain, often worse in the evening, and accompanied by muscular "starts," which cause much suffering.

In *chronic synovitis*, the local phenomena resemble very much those present in the acute form, differing from the latter only in their severity. The pain of the acute form is replaced in the chronic form by soreness and uneasiness; the fluctuation may be even more distinct, the movements less difficult, and, if the disease has succeeded the acute form, in pressing over or on moving the joint there will frequently be felt a leathery crepitation, occasioned, no doubt, by plastic deposits on the synovial membrane. When the intra-articular transudation is large, having a watery consistence, the condition is sometimes called *hydrarthrosis*, *hydrops articuli*, or dropsy of the joint.

PATHOLOGY.—In simple, uncomplicated synovitis, the vascular net-work lying beneath the epithelial layer of the synovial membrane becomes distended with blood; the fringes or tufts of the membrane are also enlarged and abnormal in color. This increased vascularity and the subsequent infiltration render the membrane somewhat red and thickened, and there is an accompanying free transudation of serum into its cavity. The presence of this serum, and some small fragments of flocculent fibrin, mingled with the synovia, render the liquid contents of the joint slightly turbid. As the inflammation subsides, and the transudation becomes absorbed, the inflammatory changes in the synovial membrane gradually disappear, leaving its structure but little, if at all, impaired.

When the attack has been more than usually severe, there may be, in addition to the transudation into the articulation, an infiltration into the synovial membrane, containing large numbers of emigrant cells, with others which may be termed native cells, and which probably originate in a proliferation of the connective-tissue corpuscles. This plastic infiltration produces a thickened and opaque condition of the synovial membrane, in some respects resembling that seen in the serous membrane of the chest after an attack of pleuritis.

In cases of this kind, the nutrition of the cartilages may be slightly changed, and the fluid in the sac of the synovial membrane somewhat purulent. Even with this degree of inflammatory change, the tissues affected may return to their original condition.

TREATMENT.—The treatment of synovitis will be determined by its severity, and also by the nature of its producing cause. When it is the result of injury, perfect rest should be secured to the joint, by placing the limb in an easy position and supporting it on an immovable splint. The matter of position is very important. The limb should never be entirely straight, but should be slightly flexed; for when placed in this attitude the degree of pressure between the ends of the bones is lessened. If the tenderness and pain are severe, blood should be drawn by leeches, or by cups, applied near the articulation if the surface is sufficiently ample. The blood-letting should be followed by cold, which can most conveniently be applied by means of ice-bags. Pain must be controlled by opiates, and the bowels regulated by the occasional use of some saline laxative. Should the inflammation not yield to these measures, and the swelling of the joint become more consistent and firm, the use of alterative doses of a mercurial will be followed by the best results. The diet should consist of milk, toast, tea, and other simple articles.

When the disease has a rheumatic origin, cold applications will be obviously improper. Rest of the limb is an essential part of the treatment. A purge, consisting of calomel, followed by castor oil or the citrate of magnesia, will remove any irritating accumulations which may exist in the bowels, and at the same time correct the intestinal secretions, and it will prepare the way for such remedies as are known to exert a favorable influence over rheumatic disease. Among these nitrate of potash occupies a conspicuous place. From one to two drachms of the salt may be dissolved in a pint or a pint and a half of water, and drunk in the course of twenty-four hours. In addition to this, ten or fifteen drops of the wine of the root of colchicum may be given once in four hours; or, what answers equally well, a quarter of a grain of the alcoholic extract of colchicum and five grains of Dover's pow-

der, made into a pill, and administered every three hours. Salicylic acid, from its known power to lower the temperature and to produce an active condition of the cutaneous glands, has been extolled by some writers as a valuable remedy in rheumatic synovitis; and I can from my own experience speak favorably of its action in a number of cases. Quinine, especially if there is reason to suspect the presence of a miasmatic element in the disease, is among our most valuable remedies.

When the acute stage of the attack has passed over, but there still remain considerable swelling and articular tenderness, much relief may be derived from the application of a large blister over the joint, and the internal use of iodide of potassium associated with wine of colchicum. Ten grains of the former with eight drops of the latter may be given to an adult, with some water and syrup, four times every twenty-four hours. As soon as the joint will bear handling, it should be gently moved, in order to prevent any permanent stiffness.

Chronic Synovitis differs from the acute form of the disease chiefly in the symptoms being less severe. The joint is not entirely free from pain, or, rather, the feeling complained of is one of soreness and uneasiness; and the movements of the articulation can be made, up to a certain degree, without any acute suffering. The swelling and fluctuation may be even more noticeable than in the acute variety, constituting, as has been observed, what is commonly known as *hydrarthrosis*, *hydrops articuli*, or "dropsy of the joint,"—names founded entirely on the thin, serous, watery character of the fluid within the articulation.

Chronic synovitis usually succeeds the acute, especially when the latter has not been vigorously combated.

TREATMENT.—The treatment is always tedious, and often very unsatisfactory. The inflammatory changes frequently extend beyond the limits of the synovial membrane, and the joint is left in a weakened condition by the imperfect or embarrassed circulation incident to the plastic deposits in the synovial membrane and its surrounding connective tissue. The ligaments, in many instances, from participation in the inflammation, have lost their pliability.

Local and constitutional remedies will be demanded. The limb must be placed at rest by plaster or by leather splints so adjusted that they can be removed at pleasure. The joint should next be covered with a large blister, or smaller ones may be used, repeated at short intervals, and applied to different parts of the articulation. These may be followed by the use of stimulating liniments, such as *linimentum saponis* to which has been added some iodide of potassium and oil of amber. Pressure, either by a flannel roller or by adhesive strips carried about the joint, will prove a valuable adjunct to the other topical applications.

Internally, the iodide of potassium, when long continued, is capable of effecting great good, and, if the general health is impaired, cod-liver oil at the same time may be advantageously administered.

When the inflammation has been removed, which may be known by the disappearance of the swelling, the absence of tenderness, and the greater freedom of movement, the functions of the joint will be more perfectly restored by the use of cold or warm douches, as may best comport with the feelings of the patient. The douche should be followed by frictions, massage, and systematic movements; at the same time the support of the articulation, by strips of diachylon, gum ammoniac, or soap-plaster, must not be neglected.

Benefit will also be derived from the free use, over the surface of the joint, of the compound solution of iodine, followed by a few turns of the roller bandage.

When the articulation remains sore and somewhat stiff, becoming heated and uncomfortable towards evening, I have found very decided relief to follow the application, every night, for a short time, of a poultice consisting

of bran, salt, and vinegar. The materials composing this poultice should be placed in a bag or between two pieces of muslin, which may be basted, in order to keep the ingredients equally distributed. After being thus prepared, the bag can be dipped into some hot vinegar, and, having been wrung out, should be placed around the joint and covered with oiled silk.

When, despite all these measures, the fluid does not diminish, it will be proper to aspirate the joint and again resort to local alteratives. Should a second accumulation follow, the only prospect of cure will be by injection.

This is accomplished in the following manner. After aspirating, and allowing a small amount of the fluid to remain, two or three drachms of tincture of iodine should be thrown through the canula into the joint. The remainder of the fluid being removed, after a short time, and the opening covered with a strip of adhesive plaster, the limb should first be placed in a position *very slightly flexed*, and then thoroughly immobilized. The effect of the injection should be to kindle up a certain degree of inflammation, which, gradually subsiding, is followed by the cure of the original form of the disease.

In *SYPHILITIC SYNOVITIS*, no remedy possesses so controlling an influence over the affection as iodide of potassium, either with or without the addition of bichloride of mercury.

Strumous, pyæmic, and gonorrhæal synovitis will be noticed in their appropriate places.

Passive Synovitis.—There is a variety of synovitis which, because of the absence of all the local symptoms ordinarily characterizing the disease, except that of swelling, may be termed *passive*.

Without the concomitant signs of tenderness, pain, and abridged movement, the patient suddenly discovers that the articulation is very much swollen and the fluctuation singularly distinct, on account of the watery nature of the fluid.

Females, I think, are more frequently thus affected than males. This affection occurs in constitutions which are feeble. Richet was disposed to regard this condition as non-inflammatory, inasmuch as the synovial membrane, in those cases which afforded an opportunity for examination, was found to be even paler than in health. This appearance of the membrane does not, however, argue that there has been no pre-existing inflammation. The absence of color is readily accounted for by the depleting effects of the free transudation.

The *treatment* will not differ from that employed in chronic synovitis. When the effusion does not diminish, it should be removed by aspirating the joint, and, if necessary, by subjecting it to an injection of tincture of iodine.

ANCHYLOSIS.

When, after an attack of acute or chronic inflammation, the joint is left in a state of partial or entire immobility, it is said to be ankylosed. This immobility may occur when the limb is either flexed or extended. The Greek term *ἀγκύλη*, from which our English word *ankylosis* is derived, was originally used to express that form of articular rigidity which occurred in the *flexed* state of the limb, whilst another Greek word, *ὀρθόζωλος*, was applied by Galen to a similar stiffness when the limb was straight. At present the word ankylosis is used to express immobility of an articulation in any position.

There are two kinds of ankylosis,—*true* and *false*, or *complete* and *incomplete*.

Complete or True Ankylosis consists in the union of the articular ends of the bones by means of osseous material. The uniting bone may be intra-articular, extra-articular, or both. When within the joint, it has been preceded by more or less complete inflammatory destruction of both the car-

tilages and the thin lamellæ of bone on which they rest. The cancellated tissue being thereby exposed, granulations spring up, which, gradually coalescing, become developed into fibrous tissue, which ossifies as in the repair of compound fractures, and practically makes the two bones one. This form of ankylosis is frequently seen in the hip, knee, and elbow.

In other instances, a new formation of osseous tissue takes place outside of the joint, and bridges over the space between the contiguous bones, rendering them immovable,—as is seen in rheumatoid disease of the spine and the knee-joint. This has sometimes been regarded as an ossification of the ligaments, but improperly. It is not the ligaments which ossify in cases of extra-articular deposit. These structures undergo previous softening, and only form a scaffolding for the inflammatory infiltration, which is transformed into connective tissue and finally into callus. In instances of long-continued ankylosis, both within and without the articulation, all the joint-structures have been previously obliterated. The condition of osseous consolidation now described is sometimes designated *synostosis*.

Incomplete or False Ankylosis may be caused by morbid changes both within and without the articulation.

Those which occur within the joint are, *first*, the formation of false bands or threads, intersecting or uniting adjacent surfaces of the synovial capsule; *second*, the cicatricial contractions of the connective tissue, resulting from the union of the granulations in fungoid synovitis; *third*, the union of the duplicatures of the ligamentous capsule, which, by refusing to unfold, offer a strong obstacle to motion. This will be better understood by taking a wet ligamentous preparation of a joint, say of the elbow. When the articulation is flexed, the anterior part of the capsule will become corrugated; and when the arm is extended, the same kind of wrinkles will form on its posterior aspect. As the ligaments are not elastic, this doubling up is absolutely necessary to the proper motion of the joint. Now, as these plications are always present, whether the limb is flexed or extended, it is not uncommon, in cases of rheumatic and other forms of synovitis, for the folds to become permanently glued together and thus resist the movements of the joint. These changes are not inconsistent with a continuance of the cartilages of the articulation, though the latter will be more or less altered in color, elasticity, and form. These intra-articular adhesions or cicatrices, at first soft, become firmer by age, and may finally undergo ossification. *Fourth*, the synovial capsule and the ligaments may be so completely changed by inflammatory deposits and their organization as to lose all their original characteristics of smoothness and flexibility, and may become contracted to a degree which will render movement impossible.

The extra-articular causes of ankylosis are to be found in the contraction of muscles, and the inflammatory induration and matting together of the tissues in the vicinity of the sinuses which exist about the joint.

A joint may be stiffened and fixed by the cicatricial contraction which follows the healing of burns or scalds. These contractions, as well as those resulting from structural alterations in the deeper tissues, are sometimes sufficient to produce very considerable displacements of the bones of an articulation.

There is an articular rigidity which is due to inflammatory cohesion of the tendons and their sheaths, especially of those tendons which pass over a joint. Thus, after a fracture at the lower end of the radius, this condition most frequently exists, often causing no small difficulty in restoring the function of the articulation of the wrist after the consolidation of the bone has been effected.

There is also a stiffness of the joint resulting from its disuse, which is important enough to merit notice in this connection. It is due to the lack of synovial and bursal secretion, from the want of the stimulus of motion. Even the articular cartilage will undergo fibrous degeneration if an articula-

tion remains long unmoved. Ginglymoid joints are more frequently the subjects of incomplete ankylosis than ball-and-socket joints. Of the first class, the elbow and knee are notably liable to the disease; of the second class, the hip furnishes numerous examples.

DIAGNOSIS.—To determine whether a case of ankylosis be true or false, the examination must be conducted under the influence of an anæsthetic. The resistance offered by the voluntary muscles is quite sufficient to fix a joint which upon the suspension of consciousness by ether or chloroform is found to possess considerable mobility. When the consolidation is osseous, the articulation will be alike immovable with or without an anæsthetic. Even in fibrous ankylosis, if the cicatricial bands are broad and very short, the ends of the bones may be bound together so firmly as scarcely to allow of any movement whatever.

TREATMENT.—The treatment of ankylosis must be governed by the nature of both the remote and the determining causes, and by that of the resulting disability. When it originates in a constitutional vice, like struma, or when the structures of the joint have been hopelessly disorganized by the ravages of any form of inflammation, ankylosis constitutes the most desirable termination, and should be favored by all possible measures. The most potent of these measures is immobilization, secured by placing the part upon an accurately fitting splint.

The surgeon must see that, before this is allowed, the limb is placed in a proper position for future usefulness. Unfortunately, this precaution is often overlooked. It is by no means an uncommon event to witness cases in which the femur has been permitted to become solidly fastened in the acetabulum, with the thigh flexed on the abdomen; or the knee-joint immovably fixed, with the leg flexed at almost a right angle with the thigh; or the elbow stiff, with the forearm extended in a line with the arm. Accordingly, when a faulty position is observed, it must be corrected at the earliest possible moment, as time rapidly intensifies the rigidity, not only by shortening the fibrous adhesions, but by transforming them into bone.

There is, however, a large number of cases in which it is proper to resist the tendency to ankylosis, or to overcome it when it already exists. Examples of these cases are, when it results from sprains, dislocations, and fractures, or when it follows an attack of articular or pyæmic rheumatism. With a view to prevention, the value of an early and vigorous treatment of the primary disease or injury—that of which the ankylosis is a sequence—will be apparent.

Whenever the inflammation of an articulation is acute in its character, the plasticity of the transudation, and consequently its tendency to organization, will be materially lessened by the local abstraction of blood, the administration of a brisk purgative, and the application of a blister, accompanied with rest of the joint, for the first few days of the attack.

As soon as the active symptoms have been subdued, very gentle movements of the articulation should be made, with a view to sever any adherent threads of lymph which may be present, and to secure their absorption. These movements must necessarily be practiced with the greatest caution and delicacy at first, until the tolerance of the joint is ascertained, when, if the inflammation is not revived, they may be repeated, and with greater freedom at each successive manipulation.

In incomplete ankylosis (or that due to false bands of cicatricial tissue, or to close adhesions within the joint, which have occurred either through neglect or in defiance of prophylactic measures), it will be necessary, in order to correct a faulty position or to restore the ordinary movements of the articulation, to resort to the use of force, and, not unfrequently, to tenotomy.

It is proper, before describing the manner of effecting the disruption, to state that, while mobility can generally be re-established, it will rarely be as complete and free as that normally belonging to the joint.

The force necessary to overcome false ankylosis may be either manual or instrumental. The older surgeons used the latter, applying the force by mechanical appliances, all of which were designed to act gradually. These appliances have been greatly improved in later times, and are still occasionally employed, as will presently be noted.

Anæsthesia, by its power to relieve pain and to relax muscular contraction, has rendered signal service to the surgeon in the treatment of ankylosis. It was Langenbeck who, in 1846, first demonstrated the facility with which deformed joints could be straightened by the use of chloroform. Under the operation of this agent the muscles were wholly removed from the influence of the will, and allowed themselves to be elongated without opposition; whereas without an anæsthetic the resistance would have been so energetic that nothing short of tenotomy could have successfully overcome the spasmodic action.

In applying manual force with a view to correct ankylosis, that portion of the limb above the stiff joint must be firmly fixed upon a table with one hand, while the portion below is grasped and moved with the other. For example, when the elbow-joint is found flexed and stiff after etherization, the arm must be the part fixed, and the forearm the part moved. When the knee-joint has been the subject of angular ankylosis, it will be found most convenient, after etherization, to turn the patient upon the abdomen and breast, in which position the leg can be handled with greater advantage. When the elbow or the knee has been left ankylosed in a straight position, the disruption of the adhesions will be most readily effected by bending the joints over the knee.

Great caution and gentleness are to be observed at the commencement of all these manual efforts. The part should be moved for some time backward and forward without using much power. As the rigidity begins to yield, and the extent of the motion increases, a greater degree of force may be exercised. The progress of the operation will frequently be announced by the rupture of the adhesion and the cicatricial bands, the crackling of which may be both felt and heard as the parts are moved.

Rashness in the incipient steps of this manipulation may result in fracture, especially if the ankylosis is one which has succeeded rheumatism, or occurs in an aged person, in whom the conditions favor a structural change in the bones, rendering them more than ordinarily brittle. I once, notwithstanding that the greatest prudence was observed in handling the limb, broke the neck of the femur outside of the capsular ligament when endeavoring to overcome a soft ankylosis of the hip-joint; and I witnessed a similar accident happen to a surgeon who, in attempting to break up the rigidity of a knee-joint, severed the femur at its lower third.

After the rupture of the articular adhesions, and when the function of the joint has been measurably re-established, it may be found that its full motion is still opposed by the shortened state of some of the muscles, or by contraction of an adjoining aponeurosis, in which event their subcutaneous division will be indicated.

After the resistance has been surmounted, and the evil position corrected, a splint should be applied before the patient comes from under the influence of the anæsthetic, so as to maintain the advantage already gained.

Although it is often requisite to exert very great force before the joint can be loosened, it is surprising how little pain, swelling, or other inconvenience is afterwards experienced by the patient. Should, however, active local symptoms follow, the use of cold anodyne lotions, as lead-water and laudanum, or the application of an ice-bag about the articulation, with the exhibition of anodynes, administered either by the mouth or hypodermically, will generally promptly remove the inflammatory disturbance. When the object is merely to correct a vicious posture of a limb, and not to obtain permanent mobility, the splint may be allowed to remain ten days or two weeks, unless it should create uneasiness by making undue pressure at some

point on the surface of the limb, in which case it must be removed and re-adjusted.

When the object is to secure permanent mobility, it will be necessary, after breaking up the adhesions and waiting for three or four days for the joint to lose its tenderness and heat, to begin passive movements, and to repeat these daily more and more energetically, until the plastic and other products of inflammation have been rubbed down and absorbed. The patient should also be encouraged to practice the various movements of the limb, using it in any way that may conduce to the motion of the joint.

When the disruption of the ankylosis has been effected by manual force, or in cases where the patient will not consent to this measure, the malposition of a joint may be lessened or often be gradually corrected by the employment of an apparatus which, through the operation of a screw, can be made to straighten or to flex the limb in a very gradual manner. The instruments represented in Figs. 1014, 1015, 1016 are among the best contrivances for this purpose.

When the lower limb is the subject of the disease, and the adhesions are broken up, the deformity may often be corrected by gradual extension with adhesive plaster, weights, and pulleys.

True ankylosis, or that in which the union of the articular ends of the bones is osseous, requires

for its correction something more than the employment of force. When, after articular disease, a joint is left immovable by a new formation of bone, the limb being in a position favorable for use, no surgeon would for a moment contemplate any interference whatever. Unfortunately, however, through ignorance or carelessness in the man-



Apparatus for straightening the knee.



Apparatus used in ankylosis of the elbow.

agement of articular disease, ankylosis is sometimes permitted to occur in positions of the affected joint which entail not only deformity, but serious disability, the correction of which becomes imperative. Until the time of

Dr. John Rhea Barton, such cases, regarded as irremediable by any conservative method, were doomed to amputation. This surgeon, in 1826, in the case of a sailor whose thigh was flexed and adducted to a degree which rendered the limb entirely useless, conceived and successfully executed an operation for the correction of the evil, which really marked a new era in the surgery of deformities. This consisted in exposing the femur by a crucial incision over the trochanter major, isolating the bone in this situation from the surrounding parts, and dividing it with a saw, after which the limb was immediately



Anterior splint, with a Stromeyer screw, for extending ankylosed elbow.

straightened. In order to establish an artificial joint, at the expiration of three weeks passive motion was instituted, and at the end of four months the man was able to move about with only the assistance of a cane.

Two modifications were made of Barton's operation, one by Dr. Kearney Rodgers, in 1830, and the other by Professor Sayre, in 1862. Both of these operations were executed in the upper part of the femur. That of Rodgers consisted in excising a wedge-shaped portion of bone from between the trochanters, thicker at the inner than at the outer side, and establishing an artificial joint at the point of separation.

Sayre, while dividing the femur at the same point, very ingeniously cut out the segment in such a manner as to initiate a ball-and-socket joint. This he did by giving a concave shape to the lower end of the upper fragment, and rounding the upper end of the lower fragment. This operation was performed twice by Professor Sayre, and in each instance with the effect of establishing a movable joint. One of the patients was living in 1876; the other died six months after the operation, from disease of the lungs. A post-mortem examination showed that the new joint possessed a capsular ligament, two round ligaments, and a synovial membrane, and that the articulating surfaces of the bone were tipped with cartilage.

In 1870, Mr. William Adams, of London, made a subcutaneous division of the neck of the femur for ankylosis with deformity. The patient was an adult, and, in addition to the section of the bone, it was necessary to divide the tendons of several muscles before the limb could be brought into a proper position. Recovery followed by ankylosis.

The instruments required for this operation are a long, delicate knife and a saw with a cutting edge extending about an inch and a half from its extremity. The knife is passed through the soft parts to the bone, in order to open a way for the saw. After the withdrawal of the knife, the saw is conducted *flatwise* along the tract until the femur is touched. It is next turned over the front of the femur, and, by the usual movements, made to cut its way gradually through. (Figs. 1017, 1018.)

FIG. 1017.



Adams's knife.

FIG. 1018.



Adams's saw for subcutaneous osteotomy.

Mr. Maunder, instead of the saw, uses a narrow chisel for cutting the bone.

Ankylosis of the knee-joint.—In attacking ankylosis of the knee-joint, several modifications of the original method of Barton have been made. Dr. Gurdon Buck, in 1844, instead of excising the wedge-shaped piece from the femur, above the condyles, removed it directly from the obliterated joint, including not only the condyles, but also the patella and a part of the head of the tibia. This surgeon, in another case, made an excision of the knee-joint.

The relative merits of the two methods have been pretty accurately ascertained by the statistics of Dr. S. W. Gross, who has collected 14 cases of Barton's operation, with only 2 deaths, and 33 cases of Buck's operation, to which may be added another excision at the knee, done at the Philadelphia Hospital, with a fatal result, making in all 34 cases, with 28 recoveries and 6 deaths, the percentage of fatal cases being nearly the same in both operations.

The subcutaneous method of division has also been applied to correct

vicious ankylosis of this articulation. This, as in the open plans already described, is executed either through the old site of the joint or above it. Thus, Dieffenbach suggested the division of the osseous band with the chisel and saw, and Malgaigne, with the chisel and mallet. Langenbeck first bored a hole almost through the joint, and, introducing a narrow saw, cut first in one direction and then in the other, thereby weakening the bone to an extent which rendered fracture an easy task.

The perforation of the bone with a drill above the joint, with a view of fracturing the femur, was proposed by Brainerd, of Chicago, in 1854. The same surgeon subsequently drilled the joint, with the same object in view, namely, to enable him by force to sever the consolidation.

Professor Joseph Pancoast demonstrated the feasibility of the first plan in a case of deformed ankylosis of the knee-joint, by boring a number of holes through the femur a short distance above the condyles and fracturing the bone.

I repeated successfully this operation on a young man in the Philadelphia Hospital, whose leg was ankylosed at a right angle with the thigh; and again at the Pennsylvania Hospital, upon a minor, whose leg was very much in the same position, and with a like favorable result. (Figs. 1019, 1020.) The operation was performed in the following manner.



Appearance of limb before operation.

The patient having been etherized, a sharp-pointed tenotome was entered at the outside of the thigh, just above the base of the condyles, and pushed down to the bone. On its being withdrawn, a drill was inserted into the same place, carried to the same depth, and made to pierce the femur, by giving a rotatory motion to the instrument. This done, and without removing the drill from the external wound, it was passed through the bone at another point, near to the joint. This was repeated a number of times, until the osseous tissue was so honeycombed that, by the use of a little force, the thigh was broken over the end of the table. The limb was now straightened and placed in a fracture-box, and a

weight was suspended from the leg.

The sides of the box were brought up, which, with the pillow it contained, exerted sufficient pressure against the sides of the extremity to prevent lateral displacement.



Appearance of limb after operation.

The drill might be driven with greater ease, and the operation shortened, if, instead of being worked by the hand, it were attached to the arm of the surgical

engine. The division of the femur might also be effected by the Adams saw.

Professor Gross, after perforating the callus of the knee-joint in different directions, divided the remaining bridges of bone with the chisel and mallet.

RESECTION is the last method of overcoming a faulty ankylosis of an articulation which I shall mention, and certainly one that should be, under any circumstances, the last expedient to which the surgeon should resort.

In deciding upon the course to be pursued in ankylosis, it will be proper

to consider—first, the exact amount of disability which the stiffness of the joint entails; and, secondly, the particular articulation involved. A finger may be fixed even in a bad position, and yet may not materially interfere with the ordinary use of the hand. The wrist may undergo osseous consolidation, and although subjecting the patient to very great inconvenience, yet in time, and under the spur of necessity, the fingers and arm will learn in a hundred ways to supplement the defect. And so it is true of the elbow; after chronic articular disease, it may be left solidly fixed at an angle unfavorable for conveying food to the mouth, for tying a cravat, or adjusting the hair, yet such is the mobility of the scapula that, under the urgency of the circumstances, a range of movement may be obtained for the arm that is truly wonderful. Even when the knee is ankylosed at a moderate angle, the disability is often provided for by a properly-constructed shoe. Whenever, therefore, through the vicarious offices of other parts, or by ingenious mechanisms, the evils of an ankylosis can be reasonably well endured, it is the wisest course, in view of the risks attending all operations, to advise against such procedures.

There will, however, still remain a considerable number of cases in which, in consequence of the extent of the deformity and the resulting disability, interference becomes imperative. And when this is the case, the next question to be determined is, what particular one of the various methods described will be best adapted to accomplish the desired result.

It may be observed here that no single operation will meet the requirements of any case of ankylosis. When the hip is the articulation affected, the operation of Mr. Adams—that of making a subcutaneous section of the neck of the femur, or of its shaft, lower down, with a saw—should be preferred. And the same operation will be equally appropriate to ankylosis of the scapulo-humeral joint. When the knee-joint is involved, the femur should be drilled, subcutaneously, above the condyles, and the bone fractured. In ankylosis of the elbow-joint, a similar operation on the humerus, near to its condyles, will be preferable to excision, or to boring and chiseling through the articulation. Indeed, when the normal joint tissues have all been destroyed, and their places are occupied by a large mass of callus, it is impossible to execute a strictly subcutaneous division of the bones.

In ankylosis of the ankle, when the foot is in a bad position, it will be a nice question to determine which will be the preferable operation,—excision or amputation. Amputation is attended with less risk than excision, and this fact should, in most instances, decide the selection.

Fibroid Formations in the Synovial Membrane.

There are occasionally witnessed two morbid conditions of the synovial membrane of a very singular nature. The first has been named the *frimbriated*, and is characterized by the presence of numerous whitish growths, having a sessile or a pedunculated attachment, varying in size from that of a mustard-seed to that of a pea, and growing from the inner surface of the membrane. (Fig. 1021.) These pendulous masses are formed of connective tissue, and have an inflammatory origin, excited, some think, by a rheumatic state of the system.

The second condition is one in which the outgrowths are situated similarly on the inner surface of the synovial membrane, and are also fibroid in their character, but are flattened, and resemble, in form and size, the seed of a melon. (Fig. 1022.)

In the movements of the joint, both of these singular formations are liable to be rubbed off from their attachments and to fall into the joint, provoking the same trouble which follows when other movable bodies enter the articulation.

Cartilage Degeneration.

The cartilages of an articulation, though designed to fulfill a mechanical office,—that of defending the ends of the bone against the wearing effects of

pressure, besides diminishing friction, and by their texture and elasticity neutralizing the effects of concussion,—are, nevertheless, living structures.

FIG. 1021.



Fimbriated synovial membrane.—Pirrie.

FIG. 1022.



Knee-joint exposed, exhibiting the synovial membrane covered with bodies of melon-seed shape.—Druitt.

The fact that, in a popular sense, they are non-vascular does not make them independent of the blood-vessels for the materials on which they subsist. Their nutrition is effected through the agency of cells, which is no less true of the other tissues of the body; the only difference is, that the attractive power of the cells upon the contents of the vessels is exerted at a greater distance than is usual in other structures; or, to use a commercial phrase in elucidating a vital process, the cartilage-consumers are compelled to transport their supplies a considerable distance from the point of delivery.

The pathology of Goodsir, Redfern, Rindfleisch, and others, which refers the ulceration of cartilages to alteration of the cartilage cells, independent of the blood-vessels, is rendered improbable by the very fact that it invades the unity of a general law to meet an exceptional case, and that a case predicated only upon an assumed limitation of the reciprocal influence exerted between the blood and the cells of a tissue.

The blood-vessels concerned in the nutrition of the cartilages are those of the plications of the synovial membrane, situated at the margin of the cartilages, where the latter are covered by an extension of the periosteum, and also those beneath the articular lamellæ of the bones. Hence it is not improper to speak of fatty metamorphosis, hypertrophy, atrophy, ulceration, and other degenerations of these structures which accompany inflammation. Weber did not deem articular cartilages exempt from inflammatory changes. The synovial membrane cannot be long the subject of these changes without the nutrition of the cartilages becoming deeply affected. Generally their involvement is secondary, and due to an extension of disease from the membrane or from the subjacent bone. It is thought by several writers that this is invariably the case, and that these structures never undergo primary

change,—an opinion in which I do not concur. I am confident that in certain forms of violence, when the articulating ends of the bones are forcibly impelled against each other, the nutrition of their cartilaginous covering is sometimes markedly affected, in consequence of the contusion to which they have been subjected, before any structural alteration is noticed in other portions of the joint. Opportunities for observing such changes are not infrequently offered in cases of railroad accidents, in which the articulations are often laid open.

The degenerative changes which the cartilages undergo may commence either upon the free or upon the attached surface, according as the arthritis arises from the synovial or from the osseous structure. Some of these changes are readily detected by the naked eye. First, the cartilage loses its natural, pearly, glistening appearance, and becomes cloudy. It also swells and softens, possessing often so little resistance as to admit of being crushed between the fingers, and, after a time, it can be easily peeled off from the bone. In other instances a highly vascular layer, or a granulation layer of the synovial membrane, covers the surface of the cartilage, which, when stripped off from the latter, exposes a rough, irregular surface, as though these granulations had grown into the substance of the cartilage and consumed it. This, under certain limitations, is the case. Billroth has pictured the destructive effects of granulations when growing into the cancelli of carious bone; and the same process may be repeated in ulcerating cartilage; but it is conditioned upon pre-existing alterations in the cells of the structure. These alterations consist in proliferation and granular degeneration of these bodies, forming in the hyaline matrix irregular cavities, sometimes at one part and at other times in several parts of the intercellular substance of the cartilage, and which, opening upon the surface, give to the latter a rough, irregular, worm-eaten appearance. This granular condition extends also to the matrix, which loses its homogeneous appearance and gradually disappears. As this process advances, the cartilage, especially when the invasion has been from the osseous side, loses its connection with the bone, and on the application of slight pressure it may easily be stripped off from the latter.

If the degeneration continues to advance, one portion after another of the cartilage is consumed. A necrosed fragment often becomes detached, and falls free into the joint, until finally the whole structure disappears and the end of the bone becomes exposed. This form of cartilage change is more commonly met with than any other, and is that which is present in cases of arthritis arising from strumous or tubercular disease.

SYMPTOMS.—The symptoms denotive of cartilage degeneration are not always very pronounced. Indeed, there are not wanting instances in which very considerable destruction of this part of a joint has taken place before the disease has even been suspected. The intense, deep-seated nocturnal pains and muscular starts, which were considered by Sir Benjamin Brodie as pathognomonic of the lesion, cannot properly be referred to this source. For cartilage, being destitute of nerves so far as we know, must be insensible. Yet, as these signs point to a disease of the underlying bone, the degeneration of the cartilage, when these indications are present, may be inferentially assumed.

Of more significance is the grating crepitation so often noticed, and also the preternatural movement of the articulating ends of the bones when forced in opposite directions,—a movement resulting either from the disappearance of the cartilages, from the softening of the ligaments, or from both causes combined.

FIBROUS DEGENERATION.—As this transformation appears to be connected with a peculiar disease, often described as *rheumatoid arthritis*, I shall consider it under that head.

Changes in the Articular Ends of the Bones in Arthritis.—There is a peculiar interest connected with the epiphyses of the bones. Very many cases of

joint disease unquestionably begin in the articular extremities of the bones. The inflammation which commences in these parts may pursue either an acute or a chronic course, and may originate in the periosteum or in the cancellated tissue. It may be the result of local causes, such as cold or traumatic violence, or may depend on a constitutional state, as syphilis, rheumatism, or tuberculosis. Occurring in the young, it is very frequently the effect of a pre-existing constitutional vice derived from tubercular antecedents.

The subject of *strumous* or *scrofulous disease of the joints* is one about which there exists considerable diversity of opinion. While some would altogether abolish the term, as exercising a pernicious influence over the treatment of these affections, others, on the contrary, go so far as to affirm that, in children, the disease invariably arises from a diathesis of this nature. I regard both views as extreme and without any support, either in the light of modern pathology or in experience. Any extended discussion of this vexed question here would be unprofitable. But I may state that I cannot conceive how any one who has attentively studied this subject can take such extreme ground as to deny altogether the existence of an inflammation of the joints depending on a constitutional condition. The statement that in many cases of so-called scrofulous joint disease, dissection has failed to discover any tubercular deposit in the bones or elsewhere, or that the excision of diseased articulations has not been followed by a recurrence of the affection, will fail to satisfy the professional mind that there is no connection between a peculiar condition of the system and certain articular diseases. The deposition of tubercle in the epiphysis is not, in my judgment, prerequisite for the existence of the form of joint disease under consideration, though such a product in this situation is not uncommonly found; how often, it is difficult to determine, as few opportunities are afforded us for an examination of the bone in the commencement of the disease. The existence of a peculiar organization is all that is required. This is most frequently revealed by the presence of the characteristics of the lymphatic temperament; or, as has been stated by Professor Gross, a mixture of the lymphatic and sanguine temperaments.

The failure of the disease to reappear after excision does not in any way militate against the hypothesis of its constitutional origin. Enlarged lymphatic glands, the strumous paternity of which no one would challenge, may be removed with equal certainty that there will be no return of the growth. Aside from these considerations, upon what theory, other than that of a constitutional origin, can we explain the thin whey-like and curdy pus which belongs to these joint-affections of children? Again, if only local in their origin, why do not such affections yield to local measures of treatment, which prove so effectual in other forms of articular inflammation, instead of demanding years for their subjugation, and finally ending, in a large number of cases, under the most skillful treatment, in ankylosis, or in a complete disorganization of the articular components of the joint? Confronted with such facts, I am not prepared to reject altogether the old doctrine of constitutional organization predisposing to arthritis in young persons. This may be quite as appropriately expressed by *strumous disease* as by any other term.

ARTHRITIS.

By the term *arthritis* is understood an inflammation of a portion, or of all, of the components of an articulation. It may be acute or chronic in its nature, and may arise from causes of a local or of a constitutional character. Among the local causes are wounds, bruises, sprains, concussions, and the combined influences of cold and moisture. Arthritis arising from local causes in most instances commences as a synovitis, the inflammation subsequently extending to the other textures of the joint.

The constitutional causes of arthritis are rheumatism, gout, exanthematous disease, pyæmia, diseases of the kidneys, and tuberculosis or struma. When

arthritis has a rheumatic or a serofulous origin, the bones and the cartilages, and sometimes the ligaments, become implicated before the synovial membrane.

When the articular inflammation occurs as a sequel of scarlatina, albuminuria, or pyæmia, it is the result of blood-poisoning, and commences as a purulent synovitis. I once witnessed a case of pyæmic arthritis in a boy of about thirteen years of age, who had been wounded by the horn of a cat-fish; all the visible articulations of the body were involved. A promising young physician of Philadelphia, who died of albuminuria, in the course of his disease was attacked with a suppurative synovitis of the wrist-joint. The arthritis which sometimes attends the puerperal state, as also that which is occasionally seen to follow urethral suppuration, must be referred to blood-infection. By some, these forms of disease are considered to be metastatic, the synovial inflammation being excited by the transportation of spoiled fragments of fibrin or other material through the blood-vessels. By not a few writers the gonorrhœal variety is considered to be of a rheumatic character.

Aged persons sometimes suffer from *spontaneous arthritis*,—a form entirely defiant of treatment,—the disease not only destroying the affected joint, but also extending to the bones beyond. Persons who belong to tubercular families, and who escape bone-disease during childhood, I am disposed to believe are liable to suffer from this form of arthritis in old age. A prominent lawyer of this city, who in the later years of his life was attacked with a destructive arthritis, from which he gradually sank and died, informed me that when a child he had barely escaped hip-disease.

Symptoms.—Arthritis may begin in a manner so quiet as not to be recognized in its early stage. The patient, for some time, complains of only a little soreness of the joint, which disappears after moderate exercise, but is again experienced towards evening, after the day's duties are over, and occasions a slight limp in the gait. The discomfort is referred to rheumatism, and not until the articulation commences to swell, and the suffering becomes severe, is the serious nature of the affection suspected.

In other instances the invasion of the disease is more pronounced, and the pain is acute, deep-seated, and throbbing, attended with evening paroxysms of unusual severity, lasting far into the night. As the disease advances, the sensitiveness of the limb becomes so extreme that the patient will scarcely allow any one to approach near to the bed, as the slightest movement or jar of the extremity causes the greatest agony. The attitude of the affected member is quite peculiar; it is one which insures the most perfect relaxation of the joint-tissues. If the knee is the diseased articulation, the leg is flexed on the thigh, and the latter on the pelvis, while the entire limb is slightly abducted and rests on its outer surface.

The pain is not always referred to the same point. When the knee-joint is the subject of the inflammation, the lower part of the inner condyle seems to be most sensitive. When the disease is in the hip-joint, that part behind the great trochanter is the seat of greatest tenderness. When the elbow is affected, the parts least tolerant of pressure are those on either side of the olecranon.

Swelling, which is another sign of the disease, presents an appearance unlike that seen in uncomplicated synovitis. In the latter, the form of the enlargement is determined by the ligaments being much more prominent on those aspects of the joint where the least resistance is encountered; whereas in arthritis, in consequence of the softening of the texture of the ligaments and also from the effusion into the extra-articular fibrous tissue, the swelling is equally distributed around the articulation.

The patient is harassed with involuntary muscular "starts" of the limb, which compel him to scream out, and which not unfrequently interrupt his sleep or cause him to wake in a fright.

At this stage of the disease the arthritis may pursue one of two courses: *First*, the inflammation may gradually subside, the pain and swelling vanish,

and the joint recover, with the exception of being ankylosed to some extent, though this last condition does not necessarily follow. *Second*, suppuration may ensue within the joint and also in the connective tissue exterior. The nutrition of the ligaments is disturbed, occasioning their softening and fatty metamorphosis to a degree which, in the case of the knee, allows the lateral movements to be exaggerated. The extra-articular suppuration is sometimes the result of irritation propagated from the inflamed and suppurating synovial membrane to the subcutaneous and capsular structures, and sometimes it is the direct result of purulent extravasation by rupture of the synovial sac. Whether resulting from the one or the other cause, the extra-articular suppuration is the signal for increased constitutional disturbance, such as rigors, fever, etc., and for a more diffused, though less prominent, swelling about the joint. Abscesses often form in the limb at points remote from the articulation.

Along with preternatural mobility of the joint, a *grating crepitation* can be recognized, if the surfaces of the articulating bones are rubbed or pressed together, an evidence that the cartilages are implicated in the disease. These are sometimes eroded and extensively destroyed before the ligaments yield, giving rise to preternatural mobility of the joint.

It is proper to state that, in exceptional cases, all the changes which have been mentioned may exist, and yet neither crepitation nor undue movement be detected, a condition which may be explained by the presence of an abundant, soft, plastic transudation into the joint, or of a gelatinous transformation of the synovial membrane.

After the abscesses are evacuated the swelling of the limb diminishes. But there remain sinuses, giving egress to a thin, purulent discharge. This may wear out the patient from hectic irritation, unless he is rescued by excision or amputation.

Occasionally, even in the condition of articular disorganization just detailed, patients who have youth on their side may recover with an ankylosed joint, the discharges gradually diminishing and the sinuses one by one closing up, until all disturbance disappears, leaving a stiff and wasted limb.

DIAGNOSIS.—An *extra-articular abscess*—the only condition likely to be mistaken for a purulent arthritis—may be recognized by the following signs. The movements of the joint are not impaired; the pain is superficial and neither tensive nor periodical. The swelling also in the extra-articular abscess is local, or confined to one aspect of the joint. But in arthritis motion of the articulation is attended with great suffering; the pain is deep, throbbing, attended with evening exacerbations, and the swelling is diffused, or involves the whole articulation.

PATHOLOGY.—The structural changes incident to arthritis affect more or less all the components of a joint. They may be considered under the following heads: first, changes in the *synovial membrane*; second, changes in the *cartilages*; third, changes in the *bones*; fourth, changes in the *ligaments*.

Changes in the Synovial Membrane.—The changes which occur in the synovial membrane as the effects of arthritis are different in some respects from those which have been described under the head of acute synovitis, inasmuch as in the former the inflammation is chronic rather than acute in its character. Injection of the synovial vessels and plastic infiltration of the membrane, together with a large serous effusion, constitute the leading phenomena of the acute form of arthritis, and if the morbid action be still more intense, it may end in suppuration, ulceration, and even destruction of the synovial membrane. But in the chronic form, that under consideration, the inflammation shows no tendency to destroy this structure, but rather to thicken it by fibrinous and cell infiltration, much in the same manner as successive attacks of pleuritis cause great increase in the thickness of the serous lining of the thorax. It is not uncommon, in old cases of chronic arthritis, to find the synovial membrane from one-fourth to three-fourths of an inch in thickness.

But a still more notable change is the production of a *granulation tissue* in such abundance as to form a thick, grayish, or dark-red, fungous layer, which has been termed by Sir Benjamin Brodie the *pulpy* and by Swain the *gelatiniform* degeneration. This fungoid tissue is moderately vascular, and is filled with serum and granular matter, imparting to it a soft, flabby consistence. Bonnet and Paquet have each made a chemical examination of this tissue, the former finding much fibrin, and the latter, mucin, in its composition. Numerous fusiform and stellate cells have been noticed intermingled with the other constituents of the jelly-like substance.

Possessing as it does loops of blood-vessels supported on a basis of fibrin with spindle-shaped cell-forms, this singular structure may be regarded as an imperfectly organized granulation tissue, and in many respects resembles the half-rotten substance which is found in the cavity of a necrosed bone.

Though Sir Benjamin Brodie believed that this fungoid condition was peculiar to the synovial membrane of the knee-joint, later observations show that other articulations suffer from this same degeneration. Mr. Hodgson has seen it in the ankle; Mr. Erichsen, in the elbow; Pirrie, in the shoulder; and it has been seen by myself in the wrist.

The pulpy degeneration, though occasionally met with at all periods of life, is more peculiarly a disease of childhood. Its constitutional origin is disclosed by the spontaneous manner in which it begins, there being generally no antecedent injury to explain its occurrence.

SYMPTOMS.—This variety of arthritis, at its commencement, manifests itself by some stiffness of the joint, attended, when in the knee or ankle, by a slight lameness. The swelling of the joint is uniform, colorless, doughy to the feel, and without fluctuation. Very little pain is experienced during the incipency of the disease. The presence of a soft, flabby swelling, and the whiteness of the skin covering the articulation, are sufficient to distinguish this form of synovial disease from an ordinary synovitis. And the fact that the swelling is uniform all over the joint will also prevent its being confounded with disease beginning in the articular extremities of a bone. In the latter case the enlargement is limited to the situation of the epiphysis.

When the disease takes a favorable turn, the swelling gradually subsides and acquires a greater degree of firmness, the constitutional excitement is lessened, the appetite returns, and the patient begins to manifest a disposition to use the limb. While this may be done to a limited extent, it is not probable that the movements of the articulation will ever be restored to their original perfection. For the conversion of the granulation into cicatricial tissue within the joint, and the adhesion thereby of the synovial membrane and cartilages, must necessarily materially abridge motion. Indeed, any attempt to overcome this rigidity by forcible measures may rekindle the original disease into unmanageable activity.

When the morbid changes continue to progress, the temperature of the joint is increased, and the pain, which at first was slight, now becomes peculiarly distressing, and is attended with "jerkings" or "starts," especially at the moment when the patient falls into a doze, which immediately interrupt his rest. These "starts" are supposed to be caused by the muscles, which, during the time the patient is awake, are constantly on guard to hold the joint-surfaces in the relation most favorable for comfort, but which relax their vigilance during the moments of sleep, thus allowing the bones to change their position when the occurrence of pain suddenly summons them back to their duty. The presence of these involuntary muscular "starts," and the existence of deep, gnawing, boring pain, furnish strong presumptive evidence that the inflammation has passed from the synovial membrane to the cartilages and the bones. This inference will be corroborated if, in addition to the above signs, the muscles begin rapidly to waste and the lateral motion of the joint is increased. Usually when the cartilages are undergoing ulceration a certain amount of crepitation may be discovered if the joint is moved, though their rough surfaces may be so covered with the fungoid granulations

as to render the sound inaudible. It is under such circumstances also that, when the articulating surfaces are forced towards each other, they appear to be opposed by some intermediate elastic substance, which is, doubtless, the excessive pulpy granulations within the joint.

Along with these changes suppuration takes place. Its occurrence will most likely be attended with increased pain, rigors, and febrile excitement. The pus is not always confined to the cavity of the joint; it may force its way through the softened ligaments and issue upon the surface of the joint. Even before the matter escapes from the synovial capsule, it is not uncommon to witness abscesses in the tissue external to the articulation, the openings of which long remain as sinuses, through which protrude soft granulations of a pale-red color.

The reflex irritation of the muscles, unless very carefully watched, will cause the limb to assume a position which, in the event of ankylosis occurring, will interfere very seriously with its usefulness.

TREATMENT.—The treatment of fungoid arthritis will include both local and constitutional remedies. The joint must be maintained in a state of complete rest, a condition which can only be fulfilled by the use of a properly adjusted splint.

In order to repress the growth of the intra-articular granulations and to favor their removal, external pressure should be made about the articulation. This should be done before applying the splint, and may be accomplished either by covering in the entire joint with successive strips of adhesive plaster (which should extend two-thirds round the limb), or by enveloping the articulation with cotton wool and binding it in place by the turns of a roller.

If the inflammation partakes of an acute character, the local abstraction of blood, by means of leeches, should take precedence of all other local measures.

When the inflammation is chronic in its course, the free application of the compound solution of iodine is to be preferred. Nor is it necessary, in this form of the inflammation, to insist on confinement to bed. An immovable splint, formed by a plaster roller, should be applied, including the affected limb, and, if the disease is in the lower extremity, the patient should be allowed to go about on crutches. When there are severe pains and "jerk-ing," nothing so promptly relieves the suffering as extension, by means of a weight attached to the limb.

When the disease shows a tendency to retrocede, the joint may be moved cautiously, in the hope of retaining mobility. But if the manipulations create any increase of pain it will be better to desist at once.

It must be remembered, however, that in many cases the local disease is only an expression of a constitutional condition, and consequently it is of vital importance to address our remedies to the system at large. For this purpose cod-liver oil, iodide of iron, tincture of chloride of iron, and quinine will prove productive of good effects. The diet must be nutritious, and as much as possible the patient should have the advantage of pure air.

As a cure approaches, the swelling gradually disappears; the sinuses, if any are present, gradually contract and close up; the joint becomes more fixed; the general health improves, and the patient, after many months or years, finally recovers, with an ankylosed joint and a withered limb.

Articular Disease arising from Constitutional Causes.

DRY ARTHRITIS, RHEUMATISMUS DEFORMANS, MALUM SENILE COXÆ, RHEUMATOID ARTHRITIS, OSTEO-ARTHRITIS, ETC.

The earliest notice of this disease was by Laudre Beauvais, in France. Since his time, it has been carefully studied by Dr. Adams and Prof. R. W. Smith, distinguished Irish surgeons, and in England by Dr. Haygarth. The joints which suffer most from the affection are the hip, knee, shoulder, temporo-maxillary, wrist, and those of the vertebral column, or those which,

in the ordinary course of life, are most severely taxed. Though at one time believed to be closely allied to gout, the two diseases are at present regarded as quite distinct, as in rheumatoid arthritis there does not appear to be any constitutional condition which favors the deposition of the urates in the joints or elsewhere. The disease frequently attacks simultaneously the corresponding articulations of the two sides. One form of the affection attacks the small joints, and from this females suffer more than males. The other form (*senile*) is peculiar to advanced life, and fastens upon the large articulations in preference to the small. In neither variety is there any tendency to suppuration or even to ankylosis.

CAUSES.—Surgeons are not agreed as to the causes of this singular affection. Remak thought that it arose from some irritation located in the spinal marrow; and the occasional co-existence of the disease with others depending upon certain lesions of the central masses of the nervous system, as locomotor ataxia, lends some plausibility to this conjecture. The fact, however, that it can be often traced to a sprain or a contusion of a joint, and also that it sometimes follows in the wake of an ordinary rheumatic attack, would seem rather to indicate its rheumatic relationship.

SYMPTOMS.—*Rheumatoid arthritis* is usually foreshadowed by fugitive pains and a tired feeling in the affected joint. The pain frequently partakes of a neuralgic character, shooting along certain nerves, as the saphenous, or, when the knee or the shoulder is attacked, along the circumflex.

Should the disease fasten upon the vertebral column, these pains pass round the body or down towards the hips and the lower extremities. Atmospheric changes exercise a marked influence on these symptoms. They are usually aggravated by damp, cloudy weather. After a time, the articular movements begin to become impaired; the patient, after a night's repose, experiences considerable inconvenience on first attempting to walk, but the stiffness wears away as the day advances. Pressure over the joint causes no pain, nor is the skin discolored. The joints gradually grow more out of shape and more displaced, in consequence of alteration in the form of the articular ends of the bones, and a *grating noise* is produced when the surfaces of the bones are moved on each other.

Irregular masses and nodular osseous excrescences form about the joint. These growths are in some cases sufficient to produce a dislocation of the articulation. The most singular distortions follow. The fingers are sometimes seen overlapping one another, or twisted laterally until a displaced phalanx may be even forced through the skin. The thumb generally remains unaffected.

When the spine is affected, the vertebræ are frequently bound together by bridges of bone, rendering the column inflexible (Fig. 1023), and compelling the patient to maintain a fixed position of the body, in which he is unable to bend forward or to stretch backward. Nor is the disease confined to the joint-tissues alone. The tendons become rigid and contracted, and the muscles wasted. The extension of the bony masses may be sufficient to compress the nerves, as they emerge from the intervertebral foramina, and to cause paralysis of the muscles to which they are distributed.

Osteo-Arthritis of Special Joints.—When the *hip-joint* is attacked, the patient

FIG. 1023.



Spinal column from a case of rheumatoid arthritis.

suffers pain in walking. The functions of the joint become increasingly impaired, so that difficulty is experienced in bending forward, standing erect, or sitting, in which last posture the limb is kept extended. The pelvis becomes tilted or oblique, and the rotundity of the buttock is lost in consequence of atrophy of the gluteal muscles. It becomes flattened, and without the groove which, in health, so sharply separates it from the thigh. The limb also shortens and becomes everted, sometimes inverted, and, when rotated, gives rise to a rude crepitation. Though the nates and the thigh waste, yet it has been observed that the leg continues for the most part unchanged.

The shortening and crepitation present in osteo-arthritis of the hip might induce a careless observer to mistake this disease for fracture of the neck of the femur. But, when the chronic course of the affection is considered, and also the absence of any injury to account for the trouble, the error can easily be avoided.

Osteo-arthritis of the *shoulder* commences much in the same manner as that of the hip,—with stiffness, nocturnal pain, and crackling or dry crepitation. In consequence of the increased synovial accumulation the joint becomes swollen, and the movements of the arm become more and more circumscribed, especially that of abduction. The swelling gradually disappears, the deltoid muscle shrinks, and the entire shoulder has a wasted appearance. In some cases the intra-articular portion of the tendon of the biceps muscle is destroyed, and the head of the bone is entirely displaced from the glenoid cavity by the bony outgrowths. (Fig. 1024.)

The tolerance to pressure, the dry crepitation, and the absence of severe pain, and of any tendency to suppuration or to marked constitutional disturbance, are signs that will serve to distinguish this disease from any other inflammatory affections of the shoulder-joint.

Osteo-arthritis of the *temporo-maxillary articulation* is peculiar to old persons,—rarely seen in the young. It is generally bilateral, and induces changes in both condyles of the inferior maxillary, and in the glenoid cavity of the temporal bone; the former becoming altered in form, sometimes enlarged, and at other times atrophied, or even entirely destroyed. The cartilages, articular and inter-articular, disappear, and the movements of the jaw are attended with a crackling sound. The alteration in the form of the articulation may cause great deformity of the face and difficulty of motion of the jaws, sometimes ending in ankylosis. Eburnation is rarely seen in the temporo-maxillary joint.



FIG. 1024.
Rheumatoid or osteo-arthritis of the shoulder-joint, destroying the bicipital tendon and displacing the humerus from the glenoid cavity.—From a specimen in the museum of the College of Physicians, Philadelphia.

Osteo-arthritis of the *knee-joint* may appear at any period of life. The synovitis which generally ushers in this disease causes considerable swelling of the joint at first. The pain is marked, and is referred generally to the internal condyle of the femur or tuberosity of the tibia. Both the limb and the joint become deformed. The leg soon changes to the flexed position. The tibia is turned outward, causing eversion of the foot, and at the same time, through an alteration in the relations of the internal condyle of the femur to the tuberosity of the tibia, it allows the knee to become strongly inclined inward. The rigidity of the joint increases; any motion of its surface is accompanied by crackling. The patella is frequently changed in form, and may undergo displacement from the surfaces of the femur. Irregular

masses of bone appear about the margin of the articular surfaces of the joint; and often, in the cavity of the latter, are seen loose fragments of disintegrated cartilages.

PATHOLOGICAL CHANGES.—The heads of the articulating bones—*e.g.*, those of the humerus or the femur, or the condyles of the latter—become flattened and dwarfed. Bony outgrowths also, which may gradually restrict the normal movements of the joint, or even cause, as has been previously stated, a spontaneous luxation, encroach upon or spring from the articulating cavities.

The change which occurs in the articular cartilage, and which seems to be peculiar to this variety of arthritis, is one in which the matrix, instead of softening, as in ulcerative inflammation, becomes broken up into fine filaments or fibres, giving to the structure a brush-like appearance. In the commencement of this degeneration the lustre and smoothness of the cartilage are lost, and its surfaces become uneven, nodular, and fissured, the clefts extending eventually through the entire depth of the structure down to the bone. Coincident with the fibrillation of the intercellular substance, the nuclei of the cartilage corpuscles multiply, the cells dividing up and enlarging the cavities in the matrix. These new cells attain a larger development than those which belong to the granular degeneration of articular cartilage; and, later on in the progress of the disease, many of them undergo a fatty transformation.

FIG. 1025.



Microscopical appearance of the articular cartilage in rheumatoid arthritis. After Weber.

Fig. 1025.) This fibrous metamorphosis does not, however, render the cartilage proof against the destructive effects of pressure. The friction to which it is subjected between the articular ends of the bones gradually wears it down, until it is ground away to a very thin layer and finally is completely removed. This new bony formation will become hard, smooth, and polished, resembling *ivory* or *porcelain*, and hence Cruveilhier applied to the process the term *eburnation*. This dense, polished surface will be found to occupy that part of the joint against which is applied the greatest pressure, as the upper surface of the acetabulum and the head of the femur, in the coxo-femoral articulation; or, where the knee-joint is the subject of the disease, the

most convex parts of the condyles of the femur. This, in turn, may be rubbed away, and afterwards replaced by the increased activity of the vessels of the cancellated tissue, until, by a continuance of the process, a part of the articulation may be beveled off, so as to give rise to a marked subluxation. This is not unfrequently seen in rheumatic arthritis of the knee.

In this disease the synovial membrane becomes thickened, and loses much of its vascularity; its duplications are thickened, and have a villous appearance; loose fragments of cartilage are found in the cavity of the joint, and even in the capsule of the latter plates of bone are deposited. The fluid within the articulation is small in quantity, and has a turbid yellow or reddish hue, and the synovia contains less mucin than belongs to the natural secretion. The tendons are frequently separated into fragments, sometimes destroyed, and their sheaths ossified.

TREATMENT.—Unfortunately, there are no remedies at our command possessing any curative power over this singular affection. The disease is incurable. The iodide of potassium administered internally is capable of affording some relief, and the same may be said of the long-continued use of Fowler's solution of arsenic. The local application of the compound solution of iodine to the surface of the affected joints may also be used with advantage. In a few instances excision has been performed for the relief of the articulation.

Strumous Inflammation of the Articular Extremities of the Bones.

When the articular epiphyses become the seat of inflammation excited by constitutional dyscrasia, they undergo very noticeable expansion. The vascularity of the cancellated structure beneath the lamellæ of compact tissue is increased, and its cells become expanded and filled with a reddish serum, intermingled with fat and medullary tissue.

The inflammation may be acute or chronic. In either case it constitutes a true rarefying osteitis, as the areas inclosed by the osseous lamellæ are greatly amplified, and their walls become in many instances a series of regularly radiating columns. The thin, compact layer which incloses the spongy tissue of the articular end of the bone also participates in the infiltration, and is diminished in thickness. The entire epiphysis becomes softened and greasy, and can readily be cut with a knife, or even crushed under the pressure of the fingers. If the nutrition of the structure is not too profoundly disturbed by the inflammatory changes, it is still possible for the bone to recover. In this event the restoration is marked by much the same changes as those which attend the repair of inflammatory disease in other parts of the skeleton, viz., the substitution of a fibrinous and cell transudation in the place of the gelatinous one, and its conversion into callus.

Should the disease advance into the articular lamellæ of the bones which support the cartilages, the latter will become affected. This is owing to the disturbance of the blood-vessels from which they derive their supply of nutritive material. The cartilages undergo granular degeneration in their totality, or in different parts, or in spots, which, commencing on their attached surfaces, advance inward towards the synovial cavity. When once this degeneration commences, their connection with the bone begins to loosen, and they are detached in fragments from its surface. Nor is the march of the inflammatory process arrested at this point; the synovial membrane is next attacked, often, indeed, simultaneously with the disease of the cartilages. The inflammation extends to it along the line of the periosteal and synovial continuity. Its folds and tufts and other portions, under the free transudation and infiltration, are gradually transformed into the pulpy or gelatinous granulation tissue, which grows into the fissures and ulcerative depressions of the cartilages, and which no doubt gives a new impetus to the dissolution of the latter.

The articular lamellæ of the bone, being exposed by the destruction of their incrusting cartilage, become increasingly vascular, soften, and disintegrate,

leaving the cancellated tissue exposed, the granulations from which extend into the joint and blend with those of the synovial membrane.

In other cases epiphyseal inflammation results in suppuration, and the abscess is discharged through an ulceration in the compact tissue of the bone into the joint. The purulent matter in such cases never presents the characteristics of laudable pus. It is a thin, discolored serum, and contains soft, cheesy masses, or it may have a gruel-like consistence and color. Not only does suppuration occur in the joint, but, by virtue of the physiological and anatomical unity of the articular and periarticular tissues, abscesses form in the soft parts external to the joint. These open upon the surface, often along sinuous tracts, and continue to discharge their contents as long as the process of disorganization is not arrested within the articulation.

The ligaments, although they may for some time withstand the articular inflammation, are eventually involved in the general ruin. In some parts they are thickened with a plastic infiltration, at others they are wasted, and in both cases they are softened so as to be easily torn.

Under the exhausting suppuration many patients perish, either worn out by hectic or by tubercular disease of the lungs, the spleen, or the mesenteric glands. Others again, with singular endurance, resist the ravages of the disease, struggling on for years, until at length the necrosed fragments of bone are expelled and a spontaneous cure by ankylosis is attained.

SYMPTOMS.—First stage.—The development of strumous arthritic disease is often exceedingly insidious. The trifling inconvenience arising from the incipient slight pain and stiffness generally receives a rheumatismal interpretation. The pains are at first transient, recurring at irregular periods, or they manifest a disposition towards periodicity, growing worse at night. The patient is able to continue his plays throughout the day, complaining perhaps towards evening of some fatigue and uneasiness, possibly of a little swelling of the articulation. After the repose of the night these symptoms vanish and are forgotten, and with the morning the child is ready to renew the active life of yesterday. This may continue for many months, the general health remaining unimpaired. It is a happy circumstance for the patient when the true nature of the malady is clearly appreciated during this primary stage.

Second stage.—As the disease progresses, the symptoms begin to assume a more positive character. The pain increases in severity, and it becomes fixed either in the joint affected, or in some part with which the latter has a direct nervous communication, as the knee in coxalgia. Not infrequently the pain, especially towards evening, is paroxysmal, amounting in some instances to agony. The suffering, at the same time, is often intensified by muscular spasms of the limb, extorting the wildest expressions of complaint. Nothing causes atrophy of a part more quickly than a painful condition of its nerves, and accordingly the nutrition of the affected limb soon becomes disturbed, and wasting follows.

Swelling of the diseased joint likewise takes place, giving rise to a sense of fluctuation from the increased synovial and serous secretion. But it is so deceptive that, to an unpracticed touch, it may readily appear to be an accumulation of pus. The integument covering the joint becomes pale and glossy, and although to the hand there is no unusual heat perceptible, the thermometer indicates some increase of temperature in the part. As the swelling of the joint augments, a change in the position of the limb takes place,—a change admitting of the greatest relaxation of the investing ligaments, and, therefore, of the largest swelling with the least tension of the articular capsule. The swelling is not limited to the synovial membrane, but after some time is increased by an inflammatory transudation into the soft parts around the outside of the joint. At this juncture the skin becomes increasingly glossy or shining, and is often marked by a configuration of veins, the evidence of pressure on the deep-seated trunks into which the superficial venous vessels empty. During this time the joint is exceedingly

intolerant of motion or of pressure, the patient shrinking from any attempt to disturb the affected extremity.

While these local changes are taking place, the constitution does not fail to share a portion of the disturbance. Fever is frequently present; the appetite is lost, sleepless nights are passed, and the patient loses both strength and flesh.

Third stage.—This stage of the disease is characterized not only by an aggravation of the local and general symptoms already detailed, but also by the evidences of a more profound disorganization of the joint-structures, *e.g.*, *suppuration*, both intra-articular and extra-articular, abscesses forming at one or more points in the vicinity of the joint, and opening upon the surface. In consequence of the softening and destruction of the ligaments and cartilages, together with the necrosis of their structure, displacements of the articular ends of the bones frequently follow, causing, in many instances, troublesome deformities. The hectic symptoms now become more marked, as indicated by the evening recurrence of fever, which, passing away in the night, leaves the patient covered with perspiration, the exhausting effects of which are witnessed in the progressive emaciation and loss of strength which follow.

Notwithstanding this formidable array of symptoms announcing the ravages of the disease, there results one compensation, namely, the absence of pain,—an effect, no doubt, ascribable to the relief from articular pressure incident to the disorganization of the ligaments.

Though it is common to group the phenomena of strumous arthritis into three stages, yet it is proper to state that very often there are no sharply-defined boundaries or lines of demarcation separating them one from another.

The anatomical and pathological conditions which form the basis for such a classification may all exist together: in other words, the different components of a joint may be undergoing the different stages of structural change at the same time. And, not infrequently, patients pass through the whole series of these changes—inflammation, effusion, suppuration, and disorganization—without experiencing any severe suffering whatever.

Prognosis.—The prognosis in a case of strumous arthritis will depend on several considerations. Among these the most important are the period at which the disease is discovered, the social condition of the patient, the age, the intensity of the dyscrasia, and the nature of the exciting cause.

When the affection is detected in its incipency, it is possible to shorten as well as to diminish the ravages which it inflicts, and, in some instances, to arrest it entirely. Even when a case of the disease is undertaken during the stage of suppuration, provided every requisite of nursing and treatment can be commanded, a favorable issue may be predicted as to the life of the patient, though not without permanent stiffness of the joint. It is in cases of this class that favorable social surroundings contribute so much to a successful result. Among the children of the poor, defective food and the absence of numberless comforts conspire to swell the mortality from the disease.

The extraordinary recuperative energies resident in the tissues of young children enable them to withstand the ravages of the affection with a greater certainty than those of advanced life can hope for. After eighteen or twenty the probabilities of recovery are materially lessened. And when the disease is developed in mature life, the prognosis is decidedly unfavorable.

The constitutional tendencies of the child have a most important bearing on the final result. Children born into the world of parents both of whom had tubercular tendencies possess but little capacity to endure the exhaustion attending this form of arthritis. The same may be said of those children who, with a favoring organization, have the articular disorder excited by some of the diseases common to childhood, such as scarlatina or diphtheria, when a few weeks may suffice to destroy the patient.

Under all circumstances, the progress of the disease is exceedingly slow.

In many instances it covers a period of several years. And one of the greatest difficulties which the surgeon will have to encounter is the want of a hearty co-operation and patient perseverance on the part of the parents or the friends of the little sufferer in carrying out the treatment until the end is reached.

TREATMENT.—In the management of this form of arthritis, the surgeon must recognize the fact that in a large proportion of cases the inflammation is the sequence of a constitutional condition which will require a considerable length of time for its elimination. His treatment must, accordingly, be both local and general.

In instituting local measures, rest and immobility are of the first importance in every stage of the disease. These measures can be effectively accomplished only by the application of plaster or leather splints which have been accurately moulded to the parts. These splints must include not only the diseased joint, but also the rest of the limb. When the inferior extremity is the part affected, and the patient is not old enough to use crutches, the benefits of rest can be secured only by enforcing unconditionally the recumbent position.

Next in importance, if used early, is counter-irritation, applied over the articulation. For this purpose blisters may be used, the surgeon repeating them from time to time and varying their position at every renewal. In young children, blisters not unfrequently cause considerable constitutional irritation. When this is the case, they should be laid aside, and resort be had to the free use of compound solution of iodine. Pain can often be alleviated by placing over the articulation a piece of thin flannel saturated with a liniment consisting of laudanum, linimentum saponis, and chloroform.

The possibility of ankylosis will suggest the propriety of placing the joint in a position which, in the event of its becoming stiff, will render the limb most useful to the patient,—a matter to be noticed when treating of arthritis in special joints.

The constitutional treatment must be determined by the state of the patient's health. In pale, delicate subjects, iron will be required, and it will be most advantageously employed by occasionally changing the form in which it is administered, at one time using the sesquichloride, and at another the iodide. When the appetite fails, quinine or tincture of cinchona will regulate the tone of the stomach. Cod-liver oil, if well digested, is also a valuable agent. When the pain is severe, it should be combated by anodynes.

The diet will demand particular attention. Milk, animal broths, meats, yolks of eggs, etc., constitute the most nutritious articles of food; in addition to which the use of wine or some preparation of malt may be allowed.

When the weather is suitable, the patient should have the benefit of the open air, and for this object, when confined to the recumbent position, he may be carried out of doors upon the bed.

When the disease occurs in subjects of a more robust nature, and whose appetite and nutrition are not disturbed, internal medicine is of little importance. When the pain in the joint is severe, especially if attended by muscular "starts" or twitchings, extension, when practicable, will afford prompt relief. This can be readily applied by means of a weight attached to the limb by adhesive plaster and suspended over a pulley, after the manner adopted in treating a fracture of the femur. In the event of the muscles refusing to submit, tenotomy may be employed.

The fixation of the joint, as the disease advances, becomes even more important than in its incipency. By some surgeons, cauterization with the hot iron, at this time, is believed to possess signal value. Seton-issues and blisters have also been advocated; but, while I am not disposed to condemn all forms of counter-irritation, I must say that I have never witnessed the salutary effects claimed for these remedies at this stage of the affection. Indeed, I do not think that any local treatment, except rest, exercises much influence over the disease. Something, however, must be done, as the value

of expectancy in surgery is not appreciated by the lay portion of the community. Accordingly, a few strips of vesication three or four inches in length may be made over the joint, from time to time, with a solid stick of nitrate of silver; or the surface may be thoroughly soaked with compound solution of iodine. If abscesses form external to the articulation, and by their extension endanger the integrity of the soft parts, they should be opened.

In neglected cases of arthritis, the limb is often found in a position in which, if it were allowed to remain, it would not only be useless but a positive incumbrance to the patient. Such malpositions must be promptly corrected by first administering an anæsthetic, and then bringing the limb to its proper place, retaining and securing it there by the use of a splint. When the muscles have undergone strong contraction, tenotomy may become necessary before correction can be effected.

When suppuration takes place, the joint may be aspirated, after which compression with a roller should be applied, and the limb again encased in the plaster or leather splint.

The patient, when sufficiently recovered, should be required to take exercise in the open air on crutches. When the inflammatory action has passed over—leaving, as it usually does, considerable thickening and swelling of the soft parts, with more or less rigidity of the joint—local remedies become exceedingly important. Stimulating liniments, friction, massage, douches, and systematic movements of the articulation comprise the most useful measures to remove the inflammatory products and prevent ankylosis. As the limb will necessarily remain weak and untrustworthy for a long time, the support of a flannel roller around the joint will be a very proper precaution.

When abscesses form, opening the joint and burrowing in the midst of the periarticular tissues, additional care must be observed to have the limb placed in a proper position, as it is more than probable that, should the patient recover, it will be with an ankylosed joint.

When exploration discloses necrosed bone, the sinuses should be dilated and the diseased osseous tissue gouged out, after which a drainage-tube should be introduced through the joint; or a seton of oakum may be inserted,—as practiced by Dr. Sayre,—and the sinuses washed out twice a day.

If the disorganization has been attended with extensive disease of the epiphysis, followed by profuse suppuration, and the patient begins to lose ground by the induced hectic irritation, excision of the joint offers the only prospect of recovery.

Throughout the progress of the disease, and especially during the period of suppuration, the patient's strength must be carefully husbanded and built up by suitable food, tonics, and stimulants.

Sometimes this form of arthritis pursues a very chronic course, the symptoms being subjective, as indicated by absence of acute pain and of muscular spasms. In such cases there is little tendency to suppuration, though the synovial membrane is greatly changed by the presence of the abundant fungous granulation tissue. Under these circumstances, the proper course of treatment is to support the articulation with adhesive plasters, over which are made to pass a few turns of a soft flannel roller. Then the joint is immobilized by means of a plaster or a silicate of soda splint. Finally, the use of crutches is directed, in order that the patient, while exercising, shall not allow the weight of the body to rest upon the foot of the affected limb.

DISEASES OF SPECIAL JOINTS ARISING FROM CONSTITUTIONAL CAUSES.

Morbus Coxarius (Coxalgia—Hip-Joint Disease).

Hip-joint disease is a very common form of arthritis, constituting about one third of all affections of this class; it is peculiar, for the most part, to childhood. Why the hip-joint should be so commonly the subject of arthritis

can only be explained by the strong pressure to which its surfaces are subjected, and the severe tension of its ligaments, caused by the extensive and multifarious movements of the joint. The shoulder possesses a similar capacity for a great range of motion, but its movements do not necessarily involve much pressure between the ends of the bones. Nor is there any inter-articular ligament like the ligamentum teres, by the twisting and tension of which, injury is inflicted on the articular surfaces of the joint. The knee sustains great weight; but its movements are only in two directions, and on this account its liability to inflammatory attacks is lessened.

Boys are more frequently the subjects of hip-joint disease than girls. Of 100 cases of this affection admitted into the Children's Hospital of Philadelphia, 61 were boys and 39 girls.* Of 837 cases of coxalgia collected from different sources, 809 were in children under fifteen years of age.

The left limb appears to be affected oftener than the right. Out of 112 cases collected by Mr. Lonsdale, in 65 the disease was situated on the left side, and in 47 on the right side.

It is usual to divide coxalgia into three stages, each being characterized by a group of symptoms peculiar to itself.

First Stage.—The symptoms indicating the commencement of this disease are often very obscure. So insidious, indeed, is its approach that in many instances serious structural changes have befallen the articulation before the existence of the affection has even been suspected. Not unfrequently coxalgia is mistaken for rheumatism, and treated accordingly.

One of the earliest signs which betoken the disease is a slight degree of stiffness in the hip, especially in the morning on rising from bed, after a previous day of active exercise. This stiffness wears away as the day fares on, but in time becomes sufficiently severe to induce the child to abandon temporarily his youthful sports. It is also accompanied by a slight limp in the gait, and frequently by pain referred to the knee. It is this last symptom which, in consequence of the knee's remoteness from the hip, often betrays the unsuspecting physician into an error of diagnosis. The pain is not unfrequently periodical, coming on in the evening and disappearing in the course of the night. These signs may continue for many weeks, in some cases for months, without undergoing any material modification. Sooner or later, however, they become more aggravated, and often at this time the child is carried to some public institution, or a consultation is requested to ascertain the real nature of the malady.

If the patient is now stripped and examined from behind, while in the standing posture, it will be observed that the weight of the body is supported on the sound limb; or, if it is transferred to the other, it will be only for a few moments.

The position assumed by the affected limb is peculiar. The thigh is slightly flexed on the pelvis, the leg flexed on the thigh, and the foot directed forward and a little outward, the entire extremity at the same time being somewhat advanced. On comparing the two buttocks, the one on the diseased side will be discovered to be a little flatter and lower than that on the sound side. The gluteo-femoral groove of the affected limb, which, normally, so sharply defines the boundary between the nates and the thigh, will also be found less distinctly marked than its fellow. (Fig. 1026.)

As in this disease the muscles about the hip are easily stimulated to resist the motions of the joint, their rigidity should be carefully tested. For this purpose, let the patient be placed on his back upon a firm, unyielding surface like a table or the floor, having the limbs flexed and parallel with each other. While thus fixed, let first the sound extremity be straightened, and the knee be pressed back until the popliteal space touches the table, which can be done without causing the least change in the loins. If now the same experiment is tried with the affected limb, it will be found that, before the ham

* Prof. John Ashhurst on Excision of Hip-Joint, Pennsylvania Hospital Reports, 1869, p. 148.

and the table can be brought together, the lumbar portion of the spine will become arched upward by the tilting of the pelvis, leaving a considerable space between the loins and the surface on which they previously rested. (Fig. 1027.) Occasionally this symptom is absent in the beginning of the disease.

FIG. 1026.



Position of the limb and appearance of the buttock in the first stage of coxalgia.

Another symptom due to muscular rigidity, and of great diagnostic value, is the elevation of the pelvis during flexion of the affected thigh. This can be ascertained by carrying the thigh towards the anterior surface of the abdomen, while the child continues in the recumbent posture. As soon as the limb passes beyond a right angle with the body, the pelvis will be seen to rise. (Fig. 1028.) The sound limb may be flexed until the anterior surface of the thigh touches the abdomen, without any perceptible tilting of the pelvis. This same muscular rigidity will be discovered in making adduction or abduction of the limb, neither of which movements can be carried to any extent without the pelvis moving in a like direction. Very early in the commencement of the disease, the nutrition of the limb becomes impaired, inducing a marked atrophy, which is the more extraordinary as in many instances there is little pain and the arthritis is scarcely distinguishable.

Pain will also be experienced when the joint surfaces are brought forcibly together. This may be done by pressing firmly against the trochanter major while counter-pressure is made against the opposite side of the pelvis. The experiment may also be made by applying the pressure to the knee or the foot. If tenderness is not discovered, and it is desirable to make the tests still more thorough, this may be done by flexing the leg and forcing the femur against the acetabulum, while the limb is placed in different positions.

Second Stage.—The symptoms belonging to this stage are, in the main,

FIG. 1027.



Arching of the loins in coxalgia when the posterior surface of the diseased limb is forced in contact with the table or floor.

those of the first stage, except that they are more positive and of greater

FIG. 1028.



Pelvis raised in flexing the diseased limb.

severity. The intra-articular transudation is increased in quantity. The

effect of this is to cause a greater eversion of the foot, abduction, and a fictitious lengthening of the limb. The flattening of the buttock is marked, and the gluteo-femoral crease is obliterated. (Fig. 1029.)

The pain is increased. Sometimes it is referred to the knee, at other times to the hip, and it often radiates up and down the limb. It is often notably worse at night. Owing to the muscular "starts" that ever and anon occur, the sleep is disturbed and fitful, the little patient waking with a scream. It is in this stage, when the symptoms are much aggravated, that the general system sympathizes with the local disorder, as is shown by the evening exacerbations of fever which set in, attended with a high temperature, and followed towards morning by perspiration. The appetite is also lost, and the emaciation becomes general.

Explanation of the Symptomatic Phenomena.—The pain and stiffness of the articulation, which mark the beginning of coxalgia, are due either to inflammation of the synovial membrane or to osteo-epiphysitis. The pain in the knee, which is commonly experienced, has been ascribed by Bonnet to the pressure of the internal lateral ligament against the condyle of the femur, caused by the malposition of the limb. A more rational explanation, and one more in accordance with anatomical facts, is suggested by the nervous communication existing between the hip and the knee. The obturator nerve supplies the former articulation, the short saphenous nerve the latter; and these two trunks are connected by a communicating branch, which passes between the external and deep femoral arteries.

There are other pains felt, in many instances, besides those in the hip and at the knee,—pains which can be explained only by reference to the agency of the anterior crural, genito-crural, and sciatic nerves.

In consequence of the synovitis an increased secretion of synovial fluid and inflammatory transudation into the articulation take place. This is always attended in any joint by a change in the relation of the joint-surfaces,—such a change as will afford the largest accommodation to the inflammatory product.

The hip-joint forms no exception to this rule, and, accordingly, we find that when its synovial capsule becomes distended with a fluid, that posture of the limb is assumed which increases the capacity of the joint, and which is the posture characterizing the first and second stages of coxalgia, viz., first abduction, and afterwards flexion and external rotation. Bonnet, by a simple experiment, demonstrated that this position is largely a mechanical result, and his experiment can be easily repeated by any one curious to witness its illustration. A hole is bored into the acetabulum from the inner side of the pelvis: into this the nozzle of a syringe, with a stop-cock attached, is inserted. If now the joint is distended by injecting water through the tube, the capsular ligament, not yielding in front, will be noticed to unfold horizontally, and the thigh will become gradually abducted. Should the capsule not give way, and more fluid be injected, the thigh will become flexed, and finally rotated in an outward direction. In coxalgia, in addition to the mechanical distention by the effusion, the muscles also operate to produce the attitude in question. There are consequently two factors concerned in causing the postural peculiarity, viz., the intra-articular effusion and muscular action. The abduction of the limb is resisted by the adductors; the flexion

FIG. 1029.



Position of the limb and appearance of the buttock in the second stage of coxalgia.

of the thigh is opposed by the hamstring muscles, and its outward rotation by the obturator internus. So that between the mechanical force of capsular distention and the vital force of muscular contractility there is a constant struggle for the mastery. The resultant of this antagonism is a marked rigidity of the joint, causing the head of the femur to be drawn tightly against the cavity of the acetabulum, which, besides giving the joint an ankylosed appearance, constitutes another cause of articular pain. This will be made more evident by the relief which is immediately experienced when the foot of the affected limb is grasped and the limb extended in the direction of the displacement, thus relieving the muscles from the task of fixing the joint.

Both the muscular rigidity and the pain are less when the disease begins in the synovial membrane than when it originates in the bone; but in either case less than would ensue were the motions of the joint left free.

The apparent lengthening of the affected limb is due to the sinking of the pelvis on the diseased side, or rather to its elevation on the sound side, in consequence of which the whole weight of the body is placed upon the sound limb.

Third Stage.—This stage of coxalgia is introduced by the signs of great structural disorganization and alterations which involve ligaments, cartilages, and bones.

The extension of the inflammation to the capsular ligament causes its softening and final rupture, either from ulceration or from extreme distention by the intra-articular effusion, allowing its contents to escape into the peri-articular tissues. The rupture of the capsule and the discharge of its contents are followed by a cessation of pain and a change in the position of the limb. In some instances the floor of the acetabulum is destroyed by caries, even before the capsular ligament gives way, when the effusion may pass into the surrounding parts. The adductor muscles now regain that controlling power which they had temporarily lost, or rather which had been usurped by the force of articular distention; and they immediately draw the thigh into a state of adduction and inversion.

As the head and neck of the femur, and frequently also the cotyloid cavity of the ileum, have, by caries and absorption, been measurably destroyed, there will be, with the other changes, more or less shortening of the limb and some degree of flexion of the thigh. This condition, again, is followed by an elevation of the pelvis on the diseased side, by which the corresponding buttock is raised higher than that on the sound side and is made to project abnormally. (Fig. 1030.) Hence the deformity of the third stage is the reverse of that noticed in the first and second stages.

The transition from the second to the third stage is variable as regards time. Generally it occurs in a gradual manner, especially when the disease begins as a synovitis. In this case the ligaments are long exempted from inflammatory changes, and when they do yield it is often over a limited region; there is, therefore, no sudden or free escape of the effusion. In some cases the change is the work of a few hours, and is the outcome of an arthritis which has been inaugurated by a primary inflammation of the epiphyses and cartilages of the joint.

The extravasation consequent upon the rupture of the capsular ligament provokes suppuration in the soft parts contiguous to the joint. Abscesses form, which, having no limiting walls, often by their diffusion inflict serious damage on the tissues of the hip and the thigh. The location of these abscesses is

FIG. 1030.



Position of the limb in the third stage of coxalgia.

not without significance. It is generally determined by anatomical peculiarities of structure. When it is above Poupart's ligament, it is not improbable that the acetabulum has been perforated; and such perforation is rendered certain when the abscess is discharged through the rectum, the vagina, the obturator foramen, or the ischiatic foramen. When the suppuration finds exit over the nates, or in the line of the gluteo-femoral fold, it is an evidence that the acetabulum is involved in the disease. Sinuses which form on the outer, anterior, or inner aspect of the thigh usually point to caries of the head and neck of the femur alone. There are, however, many exceptions to these rules.

It is not necessary for the formation of abscesses in the soft parts that the capsular ligament shall have given way. They are frequently seen when there is every reason to believe that such is not the case. They are the result of inflammation extending by continuity of tissue to the parts outside of the joint; or they arise from disturbances in the nutrition of the soft parts occasioned either by sympathetic irritation or by a wide-spread congestion of the vessels in the neighborhood of the articulation.

The differential features of the *typical* stages of coxalgia will be better appreciated by placing them in tabular contrast.

SECOND STAGE.

The thigh and knee both flexed.
The limb abducted.
The limb rotated outward, or toes everted.
The limb apparently elongated.
Pelvis lowered on the affected side.
Pelvis carried forward on the affected side.
Nates flat and low.
Pain very severe.
Abscesses occasional.

THIRD STAGE.

Generally the thigh only is flexed.
The limb adducted.
The limb rotated inward, or toes inverted.
The limb really shortened.
Pelvis elevated.
Pelvis carried backward.
Nates round and raised.
Little or no pain.
Abscesses common.

The shortening of the limb which belongs to the third stage varies in degree in different cases. It may not exceed one inch, or it may amount, in bad cases, to four or five inches. It depends on three conditions: first, the destruction, ulceration, and absorption of the head and neck of the femur; second, a change in the acetabulum; and, third, luxation of the thigh-bone. These will be considered in describing the morbid anatomy of the disease.

CAUSES.—The causes of coxalgia are both predisposing and exciting. While I do not deny the possibility of hip-joint disease being developed in a child of sound constitution, yet such an occurrence is, in my judgment, entirely exceptional. I believe that the disease originates in a state of the general system, which may be designated as strumous or tubercular. In accepting this pathology of the disease, I am consciously at variance with some very excellent authorities, though in accord with many others, whose opinions merit most respectful consideration. My convictions on this subject, however, have been formed from personal observation, quite independent of and unbiased by the views of others. It may be said that an argument which refers the origin of an arthritis to conditions which have existed, in some instances, for one or two generations is very feeble. But I am unable to discover any reason why *a priori* deductions are not as logical when applied to coxalgia as when applied to phthisis pulmonalis or to cancer. The fact that a cheesy deposit is not generally found in the epiphyses of the articulating bones does not in any way militate against the hypothesis of a constitutional origin of the inflammation. Pneumonia and pleuritis are often produced by a tubercular dyscrasia before any tubercular deposit occurs in the lungs.

If coxalgia arises solely from external or traumatic violence, why does it not yield to treatment like the inflammation resulting from common causes? Why is the pus so different from that characterizing ordinary abscesses, even though the patient may in other respects exhibit a healthy appearance? How does it come to pass that in one family of children—as I have witnessed

—there may be knee-joint, hip-joint, and spine disease? And the reasoning that imputes to this affection a traumatic origin, because the parents can often recall some injury which the child at one time received, is fallacious in the extreme. Not one lad in a thousand escapes a fall or a sprain. These are among the ordinary every-day mishaps of childhood; and, if such are to be accepted as the proximate causes of the disease, coxalgia ought to be the most common of all affections.

One of the exciting causes in many instances is, doubtless, some injury sustained by the child while engaged in play, *e.g.*, a forcible adduction of the limb, straining the round ligament, or a twist or concussion of the articulation, often, indeed, so slight that unless there had previously existed some structural condition favoring inflammation, the trifling violence would have been entirely harmless.

Exposure to cold or to a damp atmosphere not unfrequently excites hip disease, much in the same manner as similar agencies give rise to a rheumatic arthritis. Children left in a feeble condition by scarlatina, diphtheria, whooping-cough, or measles, are often the subjects of this disease; for the vital resistance which the tissues oppose to morbid influences is greatly lessened by such disorders.

PATHOLOGY.—As we have but few opportunities of dissecting the hip-joint in the early stage of coxalgia, it is difficult to pronounce with certainty what particular structure is first affected. Brodie was led by his examinations to believe that the cartilages were first attacked,—a conclusion which is set aside by more recent researches. An examination made in the advanced stage of the disease is calculated to throw but little light on this point. There are, however, strong reasons to conclude that the primary seat of arthritis is not uniform. It may begin either as a synovitis or an osteitis; and I believe it is possible to distinguish between the two. The characteristic signs of each may be tabulated as follows:

SYNOVIAL COXALGIA.

Lameness often before pain.
Pain at first slight.
Marked tenderness when pressure is made over the external surface of the joint.
Muscular rigidity moderate.
Gentle movements of the joint tolerated.
Pain not materially increased by crowding the joint-surfaces together.
Pain seldom paroxysmal.
Change in the position of the limb occurs early.

OSTEAL COXALGIA.

Pain before lameness.
Pain quite severe.
Little tenderness when such pressure is made.
Muscular rigidity extreme.
Movements not tolerated.
Pain greatly aggravated by such pressure.
Pain often paroxysmal.
Change in the position of the limb occurs late.

When the disease begins as a synovitis excited by a traumatic cause, the

FIG. 1031.



Incipient coxalgia.

inflammation commences most probably at one of the insertions of the round ligament,—points necessarily exposed to injury by violent stretching of the latter,—gradually extending to the cartilages, and finally to the bone. I am in possession of an ileum and femur taken by Dr. Willard from a lad who was suffering from incipient coxalgia, and who died from tubercular meningitis. The inflammatory redness occupied the cartilage a short distance round the acetabular and femoral attachment of the ligamentum teres, as represented in

the dark shading in Fig. 1031. Carefully prepared sections of the cartilage

were made by Dr. Shakespeare, which, under the microscope, exhibited an active proliferation of the cartilage cells, greatest on the articular surface, notably at the points where the round ligament was attached to the acetabulum and to the head of the femur, and at the reflection of the synovial membrane, but gradually lessening in the direction of the bone. (Figs. 1032, 1033, 1034, 1035.)

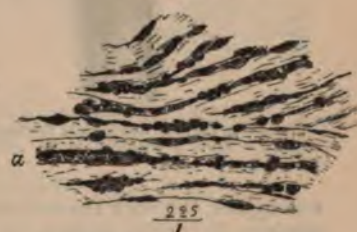
In severe forms of coxalgia all the components of the articulation undergo important structural changes. The synovial membrane, at first thickened by

FIG. 1032.



A, Attachment of the synovial membrane to the cartilage of the head of the femur; a, synovial membrane; b, fibrous tissue; c, deep portion of the cartilage.

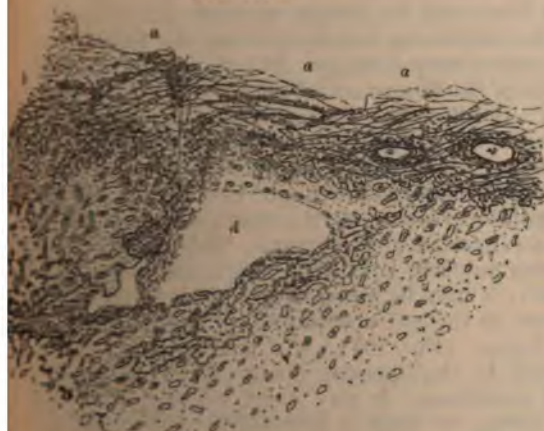
FIG. 1033.



Infiltration of deep portion of ligamentum teres near acetabulum.

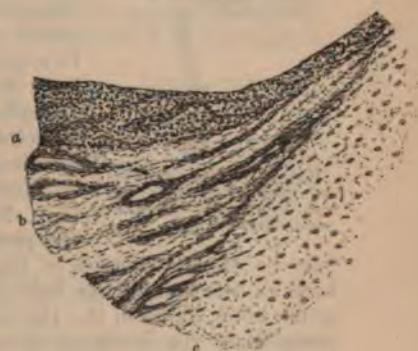
inflammatory deposits, is ultimately destroyed by ulcerative action. The capsular, round, and cotyloid ligaments are doomed to a similar fate. The femur suffers the most marked ravages of the disease. The head and neck

FIG. 1034.



Attachment of ligamentum teres to the acetabulum, with cartilage softening; a, ligament; b, line of attachment; c, cartilage undergoing softening; d, soft area filled with granulation tissue; e, space from which some tissue has fallen out.

FIG. 1035.



Attachment of the ligamentum teres to the head of the femur: a, synovial membrane with infiltration; b, fibrous tissue; c, osseous surfaces.

become carious, and are absorbed to a greater or less extent, presenting a dwarfed or stunted appearance (Fig. 1036); or the head may be entirely

detached from the neck of the bone, and lie in the cotyloid cavity. The acetabulum, though less frequently involved than the femur, is by no means exempt from the destructive inflammation; sometimes its floor is perforated (Fig. 1037); at other times it will be seen enlarged or elongated, and shallow;

FIG. 1037.



Acetabulum enlarged and its floor perforated in coxalgia. The head of the femur also in a state of caries.

FIG. 1036.



Changes in the head and neck of the femur in coxalgia.—From a specimen in the author's collection.

and again, through the action of the head of the femur, it will be held strongly against its upper surface by muscular spasm, and its upper wall undergoes absorption, so that in time the cavity shifts its position, becoming higher, either in an upward or an outward direction. In such instances it is common to find irregular masses of callus deposited about the circumference of the acetabulum, or the acetabulum filled up with callus and united to a misshapen head. (Fig. 1038.) Should the head of the femur, or, in its absence, the neck of the femur, still remain in the cotyloid cavity, the thigh-bone will be drawn upward, not only increasing the shortening, but also causing the trochanter major to project very strongly. It is the prominence of this portion of the femur, and the attending shortening, which give the limb the appearance of being luxated. In some cases, where the capsular and round ligaments have been destroyed, the head of the bone leaves its articulating cavity, and, through the action of the muscles, takes a position on the dorsum of the ileum, forming for itself a new cavity. This cavity may be near the anterior border of the innominate bone (Fig. 1039); it may be immediately behind and above the position of the old acetabulum (Fig. 1040); or it may be on the dorsum of the ileum. (Fig. 1041.) In a few instances the head of the femur has been found in the opposite direction, resting on the pubic bone, or upon the thyroid membrane. In any event, whether the bone remains in the acetabulum or forms for itself a new cavity, ankylosis,—fibrous or osseous,—in the large proportion of cases, ultimately occurs.

FIG. 1038.



Head of the femur flattened and irregular, and ankylosed with the partially obliterated acetabulum.—Smith.

DIAGNOSIS.—The diseases most nearly resembling coxalgia and with which it is most frequently confounded are the following: *dislocation, rheumatism, sacro-iliac disease, periostitis, Pott's disease, psoas abscess, psoas and iliac bursitis, and diastasis.*

As the limb assumes different attitudes in the different stages of the dis-

case, the ensuing deformity may imitate either an anterior or a posterior

FIG. 1040.

FIG. 1039.



Displaced head of the femur, forming a new socket between the anterior superior and inferior spinous processes.



Head of the femur displaced upward and outward, forming for itself a new socket, the old one being changed in form and partially obliterated.

FIG. 1041.



New articulating cavity on the dorsum of the ilium, fashioned by the dwarfed head of the luxated femur, the normal acetabulum having almost disappeared.

luxation of the thigh. The distinction will be best illustrated by contrasting the phenomena of each as below.

DISLOCATION OF THE THIGH UPWARD AND FORWARD ON THE PUBES.

Suddenly developed, and the result of traumatic violence.
Shortening of the limb.
Foot strongly everted.
Immobility greater.
Head of the bone felt beneath or under Poupert's ligament.
Trochanter in front of a perpendicular line dropped from the middle of the crest of the ilium.

COXALGIA (First Stage).

Gradually developed, and not necessarily with an injury.
Elongation of the limb.
Moderate eversion of the foot.
Immobility great.
Head of the femur not felt.
Trochanter beneath this perpendicular line.

In luxations into the thyroid foramen, the eversion and elongation of the limb closely resemble the same in coxalgia. But the anterior position of the head of the bone (which can be recognized by the touch), the history of previous violence, the anterior inclination of the body, and the greater disability which belong to the dislocation, are sufficiently characteristic to distinguish it from hip-joint disease.

It is, however, with posterior or posterior and superior dislocations that coxalgia in its third stage is most frequently confounded. In both affections the limbs are shortened and inverted; in both the trochanter is unusually prominent; in both the limbs are adducted; and in both the thigh is flexed and quite rigid. They may be contrasted thus:

BACKWARD AND UPWARD LUXATION.

The work of a moment.
No previous history of flexion, abduction, and eversion.
Head of femur can often be felt.
Pelvis unchanged.
Toes touch the ground, the heel being elevated.
Spine unchanged.

COXALGIA (Third Stage).

Slow in being reached.
A previous history of these.
Head of femur so wasted that it cannot be felt even when displaced.
Pelvis oblique or tilted.
Sole of the foot rests on the ground.
Lateral flexion of spine to accommodate the shortening.

To the above differential signs between femoral luxations and coxalgia may be added the pain experienced at the knee, the frequency of violent

muscular spasms, the relief afforded by extension, and the tender age of the patient, all of which belong to hip-joint disease.

Disease of the sacro-iliac articulation.—This affection in many respects imitates coxalgia. The symptoms common to both are lameness, pain when the joint-surfaces are pressed together, elongation of the limb, and often the presence of abscesses. A careful attention, however, to the following points will make the diagnosis clear.

SACRO-ILIAC DISEASE.

Patient inclines the body to the opposite side.
Limb not abducted nor the foot everted.
Pressure on the trochanter and counter-pressure on the tuber ischii cause no pain.

COXALGIA.

The inclination of the body is forward.
Limb everted and abducted in the first and second stages.
Such pressure does cause pain.

The difference in the two positions is what might be anticipated, as in the first affection the object is relief from pressure, while in the second it is the accommodation of the intra-articular transudation.

The counter-pressure gives significance to this test. If not employed, pain would be experienced as sensibly in one as in the other affection, inasmuch as any pressure against the acetabulum would be readily transmitted to the sacro-iliac joint.

Pressure over the posterior borders of the two ilia causes pain in the sacro-iliac articulation.
Elongation of the limb real.
No change in the gluteo-femoral fold.
If abscess and sinuses exist, a probe introduced into the latter will take a course which terminates in the sacro-iliac junction.
Pain never at the knee.

Such pressure causes no pain.
Elongation unreal.
Partial obliteration of the fold.
Will take a course towards the hip-joint.
Pain very frequently at the knee.

Psoas abscess may be mistaken for coxalgia. The following considerations will establish the distinction.

PSOAS ABSCESS.

Pain referred to the loins.
Flexion of the thigh very marked.
Extension of the limb painful.
No apparent elongation of the limb.
Neither abduction nor eversion of the limb necessarily present.
Abscess usually appears in front of the thigh, immediately external to the femoral vessels.
Impulse communicated to abscess in coughing or crying.
Generally appears after puberty.
Flexion of the thigh can be carried much beyond a right angle with the pelvis without the latter moving.

COXALGIA.

Pain referred to the hip or knee.
Flexion moderate.
Not painful.
Apparent elongation.
Abduction and eversion in the first and second stages.
Abscess rarely in this particular position.
No impulse.
Appears under puberty.
Cannot be carried to this extent without elevation of the pelvis.

Pott's disease of the spine has also been confounded with advanced coxalgia; though an error of this kind betrays a great want of careful observation. The two affections may be thus distinguished.

POTT'S DISEASE OF THE SPINE.

Pain, when present, is in the course of the spine. It may be intercostal.
No obliquity of the pelvis.
Mobility of the thigh free.
Pressing the femur against the acetabulum painless.
Antero-posterior curvature sometimes conjoined with a rotating distortion of the spine.
Nates symmetrical.
Respiration often grunting.

COXALGIA.

Pain in neither of these locations, but in the hip or the knee.
Obliquity of the pelvis.
Mobility much restrained.
Causes pain.
Compensating curve lateral.
Nates asymmetrical.
Respiration not embarrassed.

Patient stands with equal firmness on both limbs.	Rests on the sound limb.
Walks with the spine rigidly fixed.	Can bend or twist the spinal column without difficulty or pain.
Squats down in order to lift any object from the ground.	Bends down for the same object.
Paralysis of the lower extremities sometimes present.	No paralysis ever present.

Inflammation of the bursa beneath the tendons of the psoas and iliac muscles.—This affection also counterfeits hip-disease. The limb is flexed to relieve the sac from pressure. There are also lameness and swelling about the joint. The swelling, however, is confined in all cases to the inner and front part of the articulation, at which position only tenderness from pressure is felt. None is felt, as in coxalgia, when pressure is made over or behind the trochanter major. In coxalgia, flexion of the thigh cannot be carried beyond a certain point without elevation of the pelvis. In this particular form of bursitis, the limb, if cautiously manipulated, can be flexed without opposition.

There are certain conditions which are occasionally met with about the great trochanter, such as *inflammation of the bursa lying beneath the tendon of the gluteus maximus*, or a *localized periostitis of this part of the bone*, which in some respects simulate hip-joint disease. There is, however, in these affections at no period eversion of the foot; the limb can be easily crossed over its fellow and the toes inverted. In the commencement of the disease, both the tenderness and the swelling are limited to the region of the trochanter major,—the slightest pressure over this part being sufficient to cause discomfort.

Separation of the upper epiphysis of the femur.—This injury, though by no means common, does occasionally happen, and, as it must necessarily occur at an early period of life and be followed by shortening of the limb, it might be mistaken for coxalgia. When, however, it is remembered that the shortening in coxalgia is a *late* event of the disease, and is preceded by abduction and eversion, it should not be confounded with the former affection, in which the shortening immediately follows the accident, and is attended with eversion of the foot, the limb being at the same time adducted. Eversion and adduction in hip-disease do not go together, but they are consonant with the existence of a fracture through the neck of the thigh-bone. For the limb, after such an accident, when the patient is in the recumbent position, will naturally roll outward, and when in the erect position, from the same cause—its own weight—it will fall inward towards the sound extremity.

Rheumatism.—Frequently have I known coxalgia mistaken for rheumatism of the coxo-femoral articulation. And in the incipency of hip-joint disease it is often a matter of some difficulty to establish the distinction. By attending to the following considerations the obscurity may be satisfactorily dissipated.

RHEUMATISM OF THE HIP-JOINT.

A heavy ache or soreness occupying the front or outer side of the thigh.
Pain, soreness, and stiffness lessened by exercise.
Pelvis elevated on the affected side; consequently the affected limb is apparently shortened.
Wasting of the femoral portion of the limb.
Forcing the joint-surfaces together not painful.
When the limb is carefully flexed, muscular rigidity is not marked.
Soreness to pressure about the joint.

COXALGIA.

Pain at the knee.
Rather increased by exercise.
Pelvis elevated, and of course the limb is apparently lengthened.
Wasting of the entire limb.
Painful.
Very marked.
Soreness trifling.

Prognosis.—In pronouncing upon the future of a case of coxalgia, whether as to the fate of the joint or the life of the patient, the surgeon must consider, first, the age of the patient. When the disease makes its appearance after

puberty, it is much less manageable than when it occurs in young children, and frequently proves fatal.

Second. When it commences as a synovitis, and in a constitution in which the strumous diathesis is not markedly present, the prospect of effecting a cure with a useful joint will be encouraging.

Third. When the inflammation attacks the cartilages and the bones, the dangers of the case are greatly increased. For there will probably ensue caries, necrosis, and a long period of suppuration, under which should the patient not sink from exhaustion, recovery may follow with ankylosis, or after excision of the joint.

Fourth. When the disease is limited to the head and neck of the femur, it is less serious than when in the acetabulum, though it is by no means free from danger. Yet even in such cases, if treated early, the patient may recover without ankylosis.

Fifth. When, in addition to the involvement of the osseous structures immediately entering into the formation of the joint, other portions of the pelvic bones become implicated, the perils of the case are largely augmented.

Sixth. Should the disease develop at the termination of a severe attack of fever, by which the patient has been much reduced in strength, the probabilities of recovery will be materially diminished.

Seventh. In the event of the coexistence of some organic disease of an internal organ, such as Bright's disease or phthisis, or of another portion of the skeleton, such as caries of the vertebræ, the gravest termination of the case will become probable.

Notwithstanding the dangers which environ the subjects of coxalgia, the disease cannot be regarded as a fatal malady. A very large proportion of children, if put under early and proper treatment, recover, but in most instances with more or less deformity, due to ankylosis and shortening of the limb.

It is often impossible, under the most skillful management of hip-joint disease, to prevent a certain degree of deformity; but it is of a nature which is entirely

FIG. 1042.



Limb ankylosed at nearly a right angle with the pelvis.

consistent with a good use of the limb, being for the most part limited to shortening with some incurvation of the loins. In neglected or badly-treated cases,

FIG. 1043.



Limb ankylosed in the adducted position.

however, ankylosis is often seen to take place with the extremity in the most unfortunate positions. Sometimes the affected limb is strongly adducted

and fixed across the sound one. At other times the thigh is strongly flexed, even at a right angle with the pelvis. Figs. 1042 and 1043 are illustrations of such distortions.

TREATMENT.—At one time, in accordance with certain pathological views, the remedies employed in the treatment of coxalgia were entirely of a constitutional nature, little attention being given to local measures. At the present time there are three plans advocated, namely, *rest in the horizontal position*, *rest with extension*, and *extension conjoined with motion*. Absolute rest for an inflamed joint is sound treatment, both in theory and in practice; and I can conceive of no reason why the hip-articulation should form any exception to this rule. Motion without articular pressure or friction is simply impossible, and it is not in the power of man to make it otherwise. Entertaining this view, I am compelled to dissent from the teachings and practice of a number of eminent surgeons. I believe that the various mechanical appliances designed to combine extension with motion are in most instances highly prejudicial, tending to perpetuate inflammation and to favor suppuration, and thus either to prevent resolution of the arthritis or to delay ankylosis when that termination is inevitable. All the so-called walking splints, which allow the weight of the patient to rest on the affected limb, not only do not, in my judgment, fulfill the indications required in the treatment of coxalgia, but are at variance with all the principles involved in the management of the inflammation.

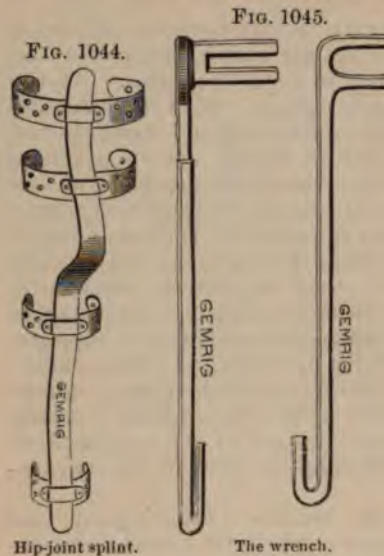
The first and paramount consideration is the fixation of the hip-joint; and if this is accomplished early, at the commencement of the disease, and enforced with scrupulous particularity, many joints will recover with excellent motion which under other plans would undergo a destructive osteitis. That patients occasionally recover under other modes of treatment I do not deny; but the result is not reached in virtue of the plan adopted, but in spite of it. What would be thought of a practitioner who should administer drastic cathartics in a case of gastritis or enteritis? Quietude is as necessary to an inflamed joint as to an inflamed intestine; functional activity and vascular tension go together. Even if it were possible to establish motion in a joint without friction, there would still remain the fact that the stimulus of the motion alone must necessarily serve to attract an increased amount of blood to the articulation, and consequently to intensify the inflammation already present, the removal of which is so necessary to the preservation of the integrity of the articular structures. Only when I have been able to carry out enforced fixation have I succeeded in obtaining the best results in coxalgia. The value of articular rest was understood by Physick, who, to effect this indication, confined the patient to the recumbent position, and employed a carved splint accurately fitted to the hip-joint.

The dressing which I employ consists of a few plain and plaster rollers, and a splint like that used by Mr. Thomas, of Liverpool, made of thin sheet-steel one inch wide and three-sixteenths of an inch thick. This splint is made long enough to extend from the middle of the posterior surface of the leg to the middle of the trunk. It is bent so as to rest close up against the tuber ischii, beneath the nates, and on it are placed two semicircular strips of strap-iron, the one on the thigh part of the iron, and the other on the leg part; these may be slid up or down at pleasure. Two short segments of metal are also connected to the upper end of the splint, and are designed to embrace half the circumference of the body. (Fig. 1044.) A shoe with a cork sole two and a half or three inches high, designed for the foot of the sound limb, is also required.

The patient must be made to stand on the sound limb, with a book, a brick, or some other body placed beneath the foot of the affected limb and sufficiently high to correct the obliquity of the pelvis and the inclination of the spine.

Next place the splint along the posterior surface of the leg, the thigh, the buttock, and the back, and bend it with a wrench (Fig. 1045) so as to make

it conform exactly to the outline of these parts. This may be easily effected, as the metal is made sufficiently flexible for the purpose. This done, the



Hip-joint splint.

The wrench.

surgeon takes a plain roller and applies it around the limb, beginning at the middle of the leg, and continuing it up to the groin, from which point it is passed to the body, and ended by a few circular turns beginning about the crests of the ilii and terminating at the lower angle of the scapula. For this roller (which is merely designed to keep the plaster from coming in contact with the skin) there may be substituted a single-legged woolen drawer, woven out of very thin material.

The next step consists in wetting one of the plaster rollers in a basin of water, and, after squeezing out the redundant liquid, applying the bandage around the limb at these points, viz., at the middle of the leg, at the knee, and around the thigh a short distance below the buttock, after which the roller is made to encircle the body as high as the inferior angle of the scapula, taking care not to touch the

crests of the ilii, which, unless this precaution is observed, are liable to become excoriated by the plaster.

The splint is now to be placed in position on the posterior aspect of the limb, pelvis, and back, fitting accurately over and under the buttock, with its branches embracing the leg, the thigh, and the body (Fig. 1046), and is to be secured by a second and third plaster roller, following the order and course of the first, that is to say, at the middle of the leg, at the knee, and around the body.

In a few minutes the dressing begins to stiffen, when the child may be laid in the recumbent position for one or two hours, in order to wait the completion of the hardening process. When this has taken place, the bandage may be slit along the anterior part of the limb and along the sound side of the body, to which portions straps and buckles can be sewed in order to hold it in place, or it may be allowed to remain undivided.

Sometimes the splint shows a tendency to slip down, and to obviate this it is well to have four stout linen loops—two in front and two behind—attached to the upper border of that part of the apparatus which surrounds the body. To these loops can be fastened strips of muslin passing over the shoulders and answering the purpose of suspenders to the splint.

Lastly, the cork-soled shoe being placed on the foot of the sound limb, the little patient can be allowed to go about on crutches. (Fig. 1047.) By this arrangement the affected extremity will be raised so far from the ground that it will be in no danger of being used, either for support or in walking.

The child when too young to use crutches must be placed in the recumbent position, on a firm mattress, and in fine weather may be taken in the open air, by placing the bed on wheels, or carrying it on a stretcher.

There is another way in which the splint can be held in position, and which answers the purpose equally well with that in which the plaster is used, namely, by leather pads and buckles attached where the segments of strap-iron are placed on the leg and body portions of the splint. (Fig. 1048.) In this manner it can be worn over a pair of thin woven drawers and be firmly secured in place. The suspenders should be added in order to prevent the instrument from slipping down.

When the limb is found in a state of flexion, and before ankylosis has

occurred, its posture can be corrected by administering ether, and gently bringing it into the proper position, after which the immovable dressing can

FIG. 1046.



Splint placed in position.

FIG. 1047.



Dressing applied.

FIG. 1048.



Splint prepared for buckling on to the limb.

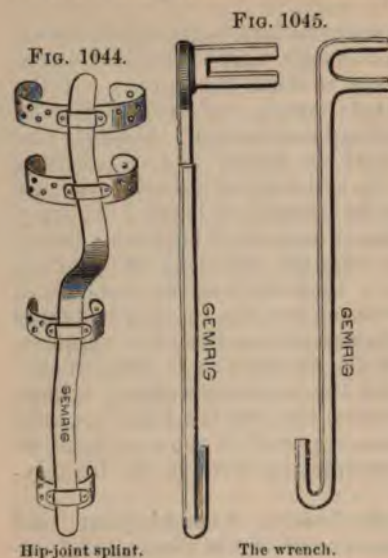
be applied. Another plan, and one which I prefer, as it is followed by no suffering or injury to the joint, is to make the correction gradually. For this purpose increasing weights must be suspended from the extremity by means of adhesive plasters, cord, and pulley, applied as in fracture of the thigh. (Fig. 1049.) Before commencing the traction, a support of pillows should be placed beneath the limb and adapted to its contracted, flexed position. The extension must always be made in the line of the deformity. As the corrective process progresses, the pillows can be lowered or altered, until the limb is finally brought into a line with the body.

Mr. Thomas, of Liverpool, uses in the treatment of coxalgia an appliance in many respects like the one which has been described, which he secures in position by plain rollers alone. I do not think, however, that the joint can be so thoroughly fixed by this plan as when the plaster bandages are employed.

In rectifying any malposition of the limb, Mr. Thomas adjusts his splint to the extremity in its *abnormal* posture, and, after the sensibility subsides, as it soon will do after the articular immobilization, he gradually corrects the deformity by altering the angle of the apparatus from time to time.

Whenever abscesses exist, the pus should be early removed by the aspi-

it conform exactly to the outline of these parts. This may be easily effected, as the metal is made sufficiently flexible for the purpose. This done, the



Hip-joint splint.

The wrench.

surgeon takes a plain roller and applies it around the limb, beginning at the middle of the leg, and continuing it up to the groin, from which point it is passed to the body, and ended by a few circular turns beginning about the crests of the ilii and terminating at the lower angle of the scapula. For this roller (which is merely designed to keep the plaster from coming in contact with the skin) there may be substituted a single-legged woolen drawer, woven out of very thin material.

The next step consists in wetting one of the plaster rollers in a basin of water, and, after squeezing out the redundant liquid, applying the bandage around the limb at these points, viz., at the middle of the leg, at the knee, and around the thigh a short distance below the buttock, after which the roller is made to encircle the body as high as the inferior angle of the scapula, taking care not to touch the

crests of the ilii, which, unless this precaution is observed, are liable to become excoriated by the plaster.

The splint is now to be placed in position on the posterior aspect of the limb, pelvis, and back, fitting accurately over and under the buttock, with its branches embracing the leg, the thigh, and the body (Fig. 1046), and is to be secured by a second and third plaster roller, following the order and course of the first, that is to say, at the middle of the leg, at the knee, and around the body.

In a few minutes the dressing begins to stiffen, when the child may be laid in the recumbent position for one or two hours, in order to wait the completion of the hardening process. When this has taken place, the bandage may be slit along the anterior part of the limb and along the sound side of the body, to which portions straps and buckles can be sewed in order to hold it in place, or it may be allowed to remain undivided.

Sometimes the splint shows a tendency to slip down, and to obviate this it is well to have four stout linen loops—two in front and two behind—attached to the upper border of that part of the apparatus which surrounds the body. To these loops can be fastened strips of muslin passing over the shoulders and answering the purpose of suspenders to the splint.

Lastly, the cork-soled shoe being placed on the foot of the sound limb, the little patient can be allowed to go about on crutches. (Fig. 1047.) By this arrangement the affected extremity will be raised so far from the ground that it will be in no danger of being used, either for support or in walking.

The child when too young to use crutches must be placed in the recumbent position, on a firm mattress, and in fine weather may be taken in the open air, by placing the bed on wheels, or carrying it on a stretcher.

There is another way in which the splint can be held in position, and which answers the purpose equally well with that in which the plaster is used, namely, by leather pads and buckles attached where the segments of strap-iron are placed on the leg and body portions of the splint. (Fig. 1048.) In this manner it can be worn over a pair of thin woven drawers and be firmly secured in place. The suspenders should be added in order to prevent the instrument from slipping down.

When the limb is found in a state of flexion, and before ankylosis has

occurred, its posture can be corrected by administering ether, and gently bringing it into the proper position, after which the immovable dressing can

FIG. 1046.



Splint placed in position.

FIG. 1047.



Dressing applied.

FIG. 1048.



Splint prepared for buckling on to the limb.

be applied. Another plan, and one which I prefer, as it is followed by no suffering or injury to the joint, is to make the correction gradually. For this purpose increasing weights must be suspended from the extremity by means of adhesive plasters, cord, and pulley, applied as in fracture of the thigh. (Fig. 1049.) Before commencing the traction, a support of pillows should be placed beneath the limb and adapted to its contracted, flexed position. The extension must always be made in the line of the deformity. As the corrective process progresses, the pillows can be lowered or altered, until the limb is finally brought into a line with the body.

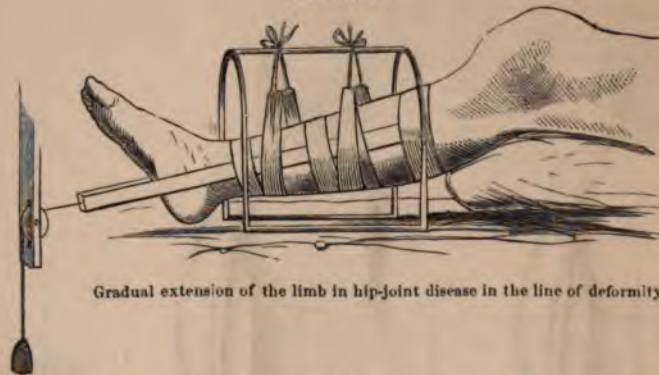
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Whenever abscesses exist, the pus should be early removed by the aspi-

rator. Should sinuses be present, traps must be cut in the plaster—if the latter is used to secure the splint—corresponding to the fistulous openings.

FIG. 1049.



Gradual extension of the limb in hip-joint disease in the line of deformity.

It will not be necessary to disturb the dressing for two or three months, unless the patient complains of constant pain and discomfort,—symptoms which indicate that the splint has not been accurately adapted to the inequalities of the limb,—in which event it should at once be removed and re-applied with greater care.

If the splint with the leather pads, straps, and buckles is employed, its removal, alteration of shape, and re-application require only a few minutes.

If the treatment is commenced in the incipency of the disease and is faithfully enforced, we may reasonably hope, in very many instances, to arrest the arthritis, secure its resolution, and preserve the functions of the articulation in the course of four or five months. Such a result will be indicated by the absence of muscular rigidity and the ability to move the joint freely without pain.

Nevertheless, it would be highly improper, even under such circumstances, to throw aside the apparatus and to abandon longer treatment. Such a course would most probably be followed by the reappearance of the inflammation in a form more intractable than that assumed at the outset of the disease. On the contrary, the treatment should be maintained with the utmost care for at least one year, when, if the mobility and painlessness of the joint continue, the patient may venture, with great caution, to use the limb for a short time every day, unincumbered by any mechanical appliance, until fully assured that the recovery is permanent; or, to insure greater safety to the joint, a splint may be worn for some time like the one represented in Fig. 1050, which fits up against the tuber ischii and possesses a perineal band. When this desirable result is not obtained, the next best result to be sought for is ankylosis. To effect this may require several years, and during this time the necessity for continuing the immovable apparatus will be imperative.

As a part of the local treatment for coxalgia, some surgeons attach much importance to the use of blisters, or to the application of the actual cautery over the outer side of the articulation. I have never seen any benefit follow the employment of either, and have long since abandoned their use.

Dr. Hutchison, of Brooklyn, New York, discards all splints in the treatment of coxalgia, using only the high shoe and the crutches, believing that the muscles are quite sufficient to secure the required immobility of the articulation. But it must be remembered that to give a joint absolute rest it is necessary that the muscles as well as the bones should be in a state of quietude. The rigidity of the muscles must necessarily invite a large amount of blood to the parts, and increase the inflammation.

Constitutional treatment is of little value when the child's appetite is good, when the rest is not disturbed, and the nutrition of the body but little im-

paired. When, however, abscesses accompanied by free suppuration exist, it will be necessary to provide for the drain on the blood-vessel system by more than usual attention to the diet of the patient. The diet should be one supplying the largest amount of plastic materials of nutrition, as milk, meats, eggs, and broths. The different preparations of iron and of cod-liver oil are also of great value. And, in order to maintain the appetite and to invigorate the digestion, the child should be

FIG. 1050.



Author's splint, sometimes worn for a few months after the cure of the joint has been effected. Front and back view.

FIG. 1051.



Davis's splint.—1, band for counter-extension; 2, swivel; 3, sliding joint; 4, buckle; 5, key with handle; 6, screw; 7, button.

much in the open air, on the crutches, or, when incapable of using them, he should be hauled about on a mattress mounted upon wheels.

Other modes of treatment.—It would be unjust to many American surgeons not to notice the ingenious plans which have been from time to time devised with a view to permit motion and at the same time to avoid joint pressure,—which is not only irreconcilable with my theory of the treatment of hip-disease, but is, I believe, an impossibility. Doubtless the reluctance with which parents consent to the *rest* treatment for their children suffering from coxalgia has had a great influence in stimulating the invention of different forms of walking apparatus. On account of this parental obstinacy and unreasonableness, the surgeon, even where his judgment disapproves, is sometimes compelled to compromise by adopting a splint of this kind, or otherwise to abandon the little patient, incapable of choosing for itself, either to the merciless experiments of charlatans or to utter neglect.

The idea of combining extension with motion in hip-joint disease originated with Dr. Davis, of New York. To accomplish this he devised the apparatus shown in Fig. 1051. It consists of an external steel splint, extending from

a short distance above the ankle to the crest of the ilium, and at the upper extremity of which is a swivel for attaching a counter-extending perineal band, partly elastic and partly inelastic. At the lower end is a screw, having a button on the outer side, near its free extremity, in which to fasten a strip of webbing, and which can be lengthened by a key at pleasure for the purpose of making extension. At the upper third of this splint is a sliding joint, by which the appliance can be lengthened or shortened, thus answering for limbs of different length; and at its lower third is attached a buckle for securing the band which surrounds the knee.

In applying the Davis splint, two longitudinal strips of adhesive plaster one inch and a half wide should be placed along the outer and inner aspects of the diseased limb, the former extending from the great trochanter to about one inch below the external malleolus, and the latter extending from the perineum to about the same distance below the internal malleolus. The lower end of each of these plasters is to be turned upward to the extent of an inch or an inch and a half, the adhesive surfaces being applied together. To the folded ends are next sewed pieces of strong, unyielding webbing, each nine or ten inches long. To render the longitudinal strips more secure, two others, of less width, should be carried about the thigh and the leg in a spiral manner (Fig. 1052), and the limb covered in by a spiral reversed roller.

If the thigh of the patient is flexed, the first object will be to bring the limb, very gradually, into the straight position. To accomplish this, the leg must be extended in a line with the femur, and both supported on pillows, with the body sufficiently raised to relax the psoas and iliacus internus muscles. In this posture extension is to be made by tying together the ends of the webbing, secured to the lower extremities of the adhesive strips, and attaching to the loop a cord, which runs over a pulley at the foot of the bed, and from which is suspended a weight. Gradually the plane on which the limb rests must be lowered, as also the body of the patient. The extremity is brought into a straight line with the trunk,—usually the work of several days.



FIG. 1052.

When this has been accomplished, the time has arrived for applying the splint, which is done as follows. The weight being detached, the steel bar is laid along the external surface of the limb over the roller; the counter-extending band is carried over the perineum and buckled into the ends of the swivel, and the webbing sewed to the end of the external adhesive strip, being disconnected from its fellow, is brought over the extremity of the screw (attached to the lower part of the splint) and made fast to the button on its outer surface. With the "handle" the screw is next turned, which, by lengthening the splint, produces both extension and counter-extension. (Figs. 1053, 1054.) In order to fix the knee, the cap is now applied, the ends of which are passed through the buckle on the outside of the steel bar. During the treatment the splint is removed at night, and the extension maintained by the pulley and weight, as in the first instance. As

soon as the extreme sensibility disappears, the patient is allowed to walk about.

The splint of Professor Lewis Sayre, acting on the principle of that of

Davis, is modified in such a manner that, for walking, extension is made from the thigh, and counter-extension from the groin, the appliance not extending below the knee.

The apparatus consists of a steel bar made up of two sections, one running within the other, and long enough to extend from the crest of the ilium to a point two inches above the lower end of the femur. This bar, by means of a key and a ratchet,

FIG. 1053.



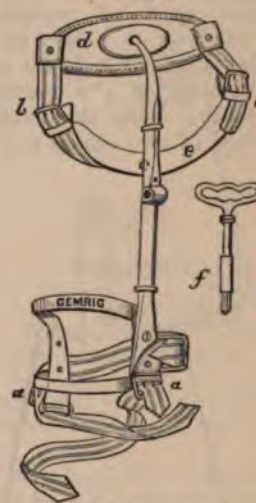
Davis's splint applied. Side view.

FIG. 1054.



Front view, without the roller.

FIG. 1055.



Prof. Sayre's hip-joint splint.

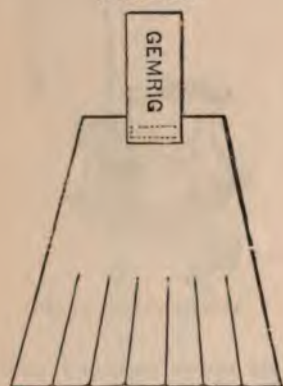
can be lengthened or shortened at pleasure. At its upper end, and connected with it by a ball-and-socket joint, is a well-padded pelvic band, to pass round a portion of the body, to which one or two perineal bands are attached for counter-extension. At the lower end of the bar is attached a rectangular branch, designed to include a part of the inner side of the thigh; and at the lower end of both the outer and inner pieces of metal are rollers, over which run the tabs attached to the ends of the adhesive plaster used for extension. Immediately above the rollers are placed buckles designed to receive the forementioned tabs. (Fig. 1055.) As this apparatus is only to be worn during the day while the patient is walking about, it is supplemented by another arrangement designed to keep up extension at night. This must be applied previous to that used for retaining the splint in place.

Two strips of adhesive plaster, two or three inches wide, and long enough to extend from the malleoli to a point four or five inches above the knee, are placed on the outer and inner sides of the leg and thigh, each having a piece of webbing, three or four inches long, sewed to the lower end. These longitudinal plasters are next secured to the leg (leaving out a part of the tabs) by a roller commencing at the foot and carried up above the knee. A portion of the upper end of each longitudinal plaster strip should be turned down over the roller, and be covered in by a few of its descending turns,—a procedure which makes the dressing more secure. A piece of board, three

inches long and one inch and a half wide, is next to be secured between the two tabs of webbing, forming a stirrup below the foot, to which is attached a cord for suspending the weight which is to make extension.

To apply the apparatus for walking, first cut two fan-shaped pieces of adhesive plaster long enough to extend one from the perineum and the other from the great trochanter to the knee, the broad portion of each being sufficiently wide to support and to embrace the semi-circumference of the thigh. They should be slit into several strips, that they may be applied with greater accuracy to the limb. To the narrow ends of these fan-shaped plasters pieces of strong, inelastic linen webbing, about four inches long, are sewed, the breadth of which must conform to the rollers on the lower ends of the branches of the metal splint. (Fig. 1056.) The plasters are now to be placed upon the thigh, the tabs of webbing reaching to points on a level with the lower extremity of the patella, where, with the exception of two inches and a

FIG. 1056.



Fan-shaped adhesive plasters with tabs attached.

FIG. 1057.



FIG. 1058.



Fan-shaped plasters applied and fastened with the roller.

half of their lower ends, they are secured by a roller. This is afterwards carried up the thigh, reversing the alternate strips of plaster, and covering them in with the bandage (Figs. 1057, 1058), until the perineum is reached, when the roller may be finished by descending turns. This done, the thigh is now prepared to receive the splint, the shaft of which must be shortened as much as possible.

The pelvic cross-bar, attached to the upper end of the instrument, is now placed immediately below the crest of the ilium, and the lower end of each branch of the appliance is attached to the limb by bringing the tabs of webbing over the rollers at their extremities and fastening them into the buckles, which are a short distance above. Next, buckle the ends of the perineal band in place, observing to interpose between it and the groin a piece of old linen to prevent excoriation.

Extension and counter-extension are next made by the key and ratchet. This apparatus, which is worn only during the day, must not be removed until the bed-extension has been applied at night.

As this mechanism does not in any way control the movements of the knee, it must necessarily allow of a greater range of motion at the hip than

that permitted by the apparatus of Davis; and this motion is altogether at variance with my notions of treating arthritis.

Professor Sayre, in some cases, employs a long splint, consisting of two bars, one of which is received within the other, and extending from the crest of the ilium to the sole of the foot, underneath which it is fastened to the shoe. At its upper extremity is an iron girdle, and to this are attached two perineal bands, one for the sound and the other for the affected limb. There is also a knee-pad. (Fig. 1059.)

A number of other walking splints are in use, as those of Hutchison, Bauer, Andrew, S.W. Gross, Pancoast, and Barwell; but they are all constructed on very much the same principle, and with a view to permit motion of the joint without articular pressure or friction,—an impossible task.

CONDITIONS REQUIRING OPERATIVE MEASURES.—There are conditions following arthritis of the hip-joint which demand surgical operations, as *vicious ankylosis* and *extensive necrosis*. In consequence of neglect, or the absence of any treatment whatever, the head of the femur may become united to the acetabulum or its vicinity, while the limb is in a position rendering it not only useless for motion or support, but a positive hindrance to both. In some instances the thigh is flexed on the pelvis; in others, it is adducted and crossed over in front of the sound limb. The ankylosis may be *fibrous* or *osseous*, but in either case is capable of correction.

Fibrous ankylosis.—In addition to the adhesion of the head of the femur to the acetabulum or its borders, the muscles will often be found greatly contracted. To remedy this, after etherization, tenotomy becomes necessary, requiring, in many instances, the division of the tendinous origins of the adductors, gracilis, tensor vaginae femoris, and rectus femoris muscles, and not unfrequently, in addition, portions of the fascia lata of the thigh. After all opposition from these sources has been overcome, a moderate degree of force will enable the surgeon to bring the limb into a proper line with the body, in which position it must be maintained either by extension with weights, or by bandaging the extremity to a long external splint, well padded, to prevent excoriations.

Bony ankylosis.—When the limb becomes solidly fixed in an evil position, by bony adhesion taking place between the innominatum and the head of the femur, nothing short of severing the bone will correct the deformity. The first operation of this kind was devised and executed by Dr. John Rhea Barton, of Philadelphia, in 1826. Professor Sayre, of New York, in performing this operation, removed a block of bone from the femur above the trochanter minor by a double incision; one part of which—the lower—was made convex across the bone; and the other—the upper—was made concave. The object was to fashion the ends of the divided femur in a manner which would favor the formation of a pseudo-ball-and-socket joint. The objection to the above plans is the necessity of making an open wound, with its attendant dangers,—an evil which is entirely obviated by the procedure of Mr. Adams, of London, who divides subcutaneously the neck of the femur instead of that part of the bone below the trochanter major.

For the execution of the last-named operation, there are required a long,

FIG. 1059.



Sayre's modification of Taylor's splint.

narrow, and sharp-pointed bistoury and a peculiarly-shaped saw eight inches in length, the teeth occupying about one inch and a half of the extremity of the blade. (See Figs. 1015, 1016, p. 145.)

Adams's operation.—The patient being etherized, and placed on the sound side or on the back, as may be most convenient, the long knife is entered immediately above the great trochanter, and carried directly on until the point comes in contact with the neck of the bone. Then it must be withdrawn, and the end of the saw entered, and passed along the same tract *flatwise*. When the bone is reached, the blunt point of the instrument must be raised, and carried over the front of the femur, and with its cutting edge turned upon the latter, when, by short back-and-forth movements, the bone can be divided. The separation once effected, the saw must be withdrawn, the small wound closed by a strip of adhesive plaster, and the limb at once brought into the proper position, and secured after the manner directed in fibrous ankylosis.

Mr. Maunder, of London, employs a narrow chisel with which he divides the femur. But the saw is to be preferred, its use being free from the risk of comminution of the bone.

Excision.—Cases will occur in which ankylosis fails,—a condition, I fear, not unfrequently invited by those plans of treatment which allow motion in the joint. The inflammation of the articular ends of the bone results in necrosis. The head of the femur, eroded and wasted, may become entirely detached from its neck, and fragments or sequestra of bone, separated from the acetabulum, may lie loose in the joint. Under these circumstances, the suppuration and hectic symptoms which attend so extensive an articular disorganization will rapidly exhaust the vital resources of the child, and render it necessary to remove all causes of irritation by excising the joint.

Before resorting to so radical a measure, the surgeon should inform himself thoroughly as to the extent of the disease and the general condition of the child. It must have been observed by any practitioner who has had much to do with coxalgia that patients make excellent recoveries by the operation of natural processes alone, notwithstanding the presence of articular suppuration and necrosis. The disintegrated particles of bone are extruded along with the discharges; after which ankylosis follows.

Whenever, therefore, an excision is contemplated, the patient should be placed under an anæsthetic, and the joint carefully explored by digital examination, the finger being carried through one or more of the sinuses, which may, for this purpose, be dilated, or, if too small, incised. In this way only can a correct opinion be formed as to the extent of articular disorganization. The probe may also be used to reach points too remote for the finger to touch, and thus aid in communicating the desired information. If, upon making such an examination, the head of the femur, or its remains, is found adherent to the acetabulum or to the ilium, the suppuration is gradually diminishing, and the health of the child is improving, it will be wise to abstain from any operation, and patiently to wait for further developments. Should loose fragments of bone be discovered, they must be extracted by the forceps through one of the fistulous openings, and the cavity of the joint must be frequently washed out with disinfecting lotions, such as the solution of permanganate of potash, nitrate of lead, carbolated water, or dilute tincture of iodine. A free drainage should be established by the use of the rubber tube, or by a rope of twisted oakum, so justly esteemed by Sayre. If, in connection with these measures, the immobilization of the hip is maintained and the general health is supported, we may entertain a sanguine hope that the case will recover by ankylosis.

The conditions which, as a rule, do not require excision, I may formulate as follows:

First. The operation is never allowable where no evidence of necrosis exists.

Second. As long as the disease is limited chiefly to the synovial membrane, without disorganization of cartilages or bone, the knife should be withheld.

Third. The operation is improper in cases in which ankylosis is progressing and the general health of the patient is not failing.

Fourth. Suppuration in itself constitutes no indication for excision. For it may exist both within and without the joint without the bone being involved.

Fifth. Partial necrosis, either of the head of the femur or of the acetabulum, does not necessarily demand the operation, unless the child is losing flesh, strength, and appetite, and presents the signs of increasing joint-disorganization.

Cases for excision.—When, however, the head and neck of the femur are found to be necrosed, with or without a similar state of the acetabulum, the propriety of excision cannot be questioned; and notably so if, in addition, the patient's health is steadily failing under suppuration and constitutional irritation.

There are cases, again, where the indications for operation are much less pronounced than the above, but which are, nevertheless, proper subjects for excision. For example, when, upon examination, the surgeon discovers no extensive bone destruction,—none incompatible with a cure by natural processes, provided the constitutional resources of the patient are sufficient to endure a long and tedious process of suppuration,—but yet there are observed a slowly-progressing but steady emaciation, loss of strength, and other signs of pyæmic irritation, under such circumstances, and with the uncertainty of the child being able to endure the exhaustion incident to a long period of inflammatory changes necessary to exfoliation or ankylosis, it will be better to cut out the diseased structure and substitute a healthy for an unhealthy one.

In turning to statistical data for some guiding light upon this important subject, a rather formidable mortuary record is encountered. Of 111 excisions of the hip-joint collected by Dr. Hodges, 56 recovered, 53 died, and in 2 cases the result was unknown. The collection made by Dr. Good, of Paris, embraces 112 cases, with 52 recoveries and 60 deaths. Mr. Holmes has reported 19 cases, with 8 recoveries, though only 3 were complete recoveries. Professor Sayre reports 39 cases, with 20 deaths, 5 of which, however, cannot be referred, either directly or indirectly, to the operation. The tables of Dr. Ashhurst comprise 470 cases of hip-joint excisions, 234 of which recovered, 192 died, and in 44 the result was not ascertained, or a mortality of 45.1 per cent. Of this number, 177 were examples of complete, and 241 of incomplete or partial excisions; in 52 the extent of operation is not stated. The determined results for the complete excisions were 90 recoveries, 77 deaths, and 10 unknown, or a death-rate of 46.1 per cent.; for the partial excisions, 124 recoveries, 97 deaths, and 20 undetermined, or a mortality of 43.9 per cent.; and for those the extent of which was not mentioned, the recoveries were 20, the deaths 18, and the uncertain 14, or a mortality of 47.4 per cent.; the average mortality for all the excisions being 45.1 per cent. If we sum up all these data, it appears that the percentage of recovery after excision is about 45. Any deductions based on the above statistics as unfavorable to excision will be entirely fallacious. They do not present the subject in a just light. For in a large number of patients the operation was undertaken only as a last resort, and when the ravages of the disease and the attendant constitutional exhaustion had necessarily diminished the prospect of recovery. Professor Ashhurst, in a paper on excisions, read before the American Surgical Association, reports 120 cases in his own practice, 40 being excisions of the hip-joint, with 11 deaths.

The age of the patient forms an important factor in the result of hip-joint excisions. Thus, in a total of 195 ascertained terminations of the operation executed for coxalgia, three-fourths (109) of the recoveries occurred in children under fifteen years of age, the mortality steadily rising to 75 per cent. at thirty years of age. Bryant, in an analysis of Hodges's and Good's tables, reaches a similar conclusion.

When the excision is made, it should include not only the head and neck

manner, by placing the limb over an inclined plane of pillows, or by swinging it from a cradle and suspending gradually increased weights from the leg, by means of adhesive plasters as in hip-joint disease. (See Fig. 1049, p. 178.) As the straightening process goes on, the plane or supporting bands can be lowered until the rectification is complete. This work may require only a few days, or it may extend over two or three weeks. Tenotomy is rarely demanded in these cases of knee-joint disease early treated.

As soon as the rectification has been effected, a plaster splint must be immediately applied, extending from three inches above the ankle to the middle of the thigh. Should any swelling ensue, the dressing can be split up in front, or it may be applied in the first instance by recurrent turns of a plaster bandage, leaving a little of the anterior surface of the limb uncovered; by a roller bandage the plaster splint can be held securely in position. Generally, however, soon after the splint has been applied, the swelling begins to subside, when it will be necessary to re-apply the plaster dressing so as to preserve an accurate support of the joint.

As soon as a noticeable amelioration of the local symptoms takes place, the patient may be allowed to rise from the bed, but under no circumstances to place the weight of the body upon the foot of the affected limb. To prevent this, and at the same time to allow exercise in the open air, a high-soled cork shoe, or a metal support under an ordinary shoe, must be worn on the foot of the sound limb, and the patient be compelled to use crutches as in coxalgia.

If the general health is impaired, it will be proper to administer cod-liver oil and the different preparations of iron and iodine. The diet should be nutritious, but unstimulating.

If the joint becomes distended with a sero-synovial or a purulent accumulation, it should be aspirated. This can be done with entire safety; it may be repeated from time to time, if necessary, and it will conduce not only to the relief of pain, but to the resolution of the inflammation. Prof. Sayre employs an apparatus in these diseases of the knee-joint which is designed to combine articular rest with extension. The instrument consists of two steel collars, one inch wide, and long enough to encircle the one the thigh and the other the leg below the joint. These collars admit of being opened, and then closed and locked by a hinge and a clasp, and are connected with each other by two

rods, which can be lengthened or shortened by a rack and pinion, worked by a key. (Fig. 1061.) This apparatus is secured to the limb by means of adhesive plasters placed longitudinally around the thigh, from the lower end of it almost to the groin, and in the same manner around the leg, from the head of the tibia to a little above the ankle. These plasters are bound to the leg and thigh by a roller, leaving about two inches of each uncovered. (Fig. 1062.) The instrument is next slipped around the thigh and the leg, and, after being adjusted, is fixed in position by turning the ends of the plaster (left uncovered by the roller) over the bands and securing them by the turn of another bandage. (Fig. 1063.)

By turning the screws connected with the lateral rods of the instrument,

extension and counter-extension are made on the knee until all sense of the pain which is experienced by standing on the foot of the affected side is



removed. After this is done, a third roller is carried from the foot to the knee, with a view to prevent swelling of the leg.

The objection to this ingenious contrivance is the difficulty of keeping the tension of the instrument uniform when the patient passes into the care of the parents; and unless this end be secured the immobility of the joint is not assured. Without the fulfillment of this indication, I hold, no articulation in a state of inflammation is in the best condition for recovery. When, however, the case can be kept under professional supervision, the apparatus may answer a very good purpose.

Thomas, of Liverpool, employs an apparatus which, by transferring the weight of the body to the ischium and perineum, relieves the knee-joint from pressure when the patient is standing or walking. This instrument consists of two parallel metallic rods, connected by a piece of sacking or leather, with a foot-piece and a metallic patten at their lower extremities, and also a ring, well padded, and attached, at an angle of fifty-three degrees, to the upper ends of the rods, and having a buckle in front and behind for the attachment of a strap. (Fig. 1064.)

This apparatus is applied by slipping the ring over the limb and carrying it up along with the lateral rods to the perineum. The foot rests on the foot-piece, and the splint is bound to the limb by two flannel rollers,—the one applied above and the other below the knee. A patten is also screwed to the shoe of the sound limb. To keep the perineal ring in place, a strap is connected to it behind, and, after being carried over the opposite shoulder, is fastened to its anterior part.

When the arthritis has resulted in a disorganization of the joint, in which the synovial membrane has become thickened by plastic deposits, the cartilages necrosed, and the articular ends of the bones carious, with sinuses through the soft parts, there are four courses of practice open to the surgeon. These are expectancy, laying open the joint and cauterizing its cavity, amputation, and excision.

With regard to the expectant plan, it may be said that as long as the general health of the patient is not seriously endangered by excessive suppuration or by hectic irritation, there is hope that a spontaneous cure may follow. It is difficult to place limitations to the curative power of natural processes. Accordingly, the surgeon may be content for a time with applying the plaster splint, in which traps are cut corresponding to the positions of the sinuses, and through which the discharges can escape, and the dressing can be applied without disturbing the joint. When these sinuses communicate with the cavity of the joint—a condition which can be ascertained by the use of the probe—and are discharging freely, the articulation should be cleared by daily injections of permanganate of potash, nitrate of lead, or carbolic water. Once or twice a week, after the use of these liquids, the compound solution of iodine, half the official strength, may be injected, or a solution of iodoform (three grains to the ounce). Under this treatment the exfoliation of the bone is hastened, the cartilages disintegrate and are ejected, and healthy granulations may spring up and solidify the joint.

FIG. 1063.



Sayre's apparatus applied.

FIG. 1064.



Thomas's knee-joint splint.

Arthrectomy.—Should no favorable result ensue, or should the caries continue to extend, it will be best to lay open the joint, and, by means of the gouge or the bone curette, cut away all the diseased osseous tissue, flushing the joint with the sublimate solution as the operation proceeds, and, upon its completion, passing a drain-tube across the articulation, dressing antiseptically, and immobilizing the limb on a splint. In some of the recorded cases of tubercular arthritis, where the disease was limited in extent, a movable articulation was preserved after arthrectomy. Of twelve arthrectomies of the knee by Boeckel, all were successful. Where the disease is confined to the synovial membrane, the operation should be confined to its removal.

Mr. Hayward,* after cleansing the joint with a mop of lint, packed its cavity with lint saturated with dilute sulphuric acid one-third the official strength, to hasten the separation of the diseased tissues, excite healthy granulations, and secure ankylosis. This plan is represented as effectual in the few cases in which it has been adopted; but so radical a method should be accepted with caution, until a larger experience shall have determined its true value. The leg must be kept in the extended position, as the ankylosis, when it occurs, is more secure in this than in the slightly flexed posture.

When the caries and necrosis of the articular ends of the bones are extensive and progressing, and the general health of the patient is failing from the suppuration and general irritation, notwithstanding that the freest drainage has been established, there remains the choice between *amputation* and *excision*. Excision is always to be preferred for children, and amputation for adults.

Ankle-Joint Disease.

Chronic arthritis of the ankle-joint is next in order of frequency to that of the knee. The inflammation may extend to the articulations of the tarsus, or the converse of this may be realized.

FIG. 1065.



Ankle-joint disease.

CAUSES.—The disease is excited, usually, by some contusion or twist of the joint, also by exposure to dampness and cold when a favoring organization exists. But it frequently arises without any known cause.

When due to a traumatic cause, the inflammation, I believe, often begins in the ligaments. These structures are peculiarly exposed to injury in consequence of the peculiar conformation of the articulation and of the strain to which they are subjected when, owing to a malposition of the foot, the weight of the body is brought to bear upon their fibres.

SYMPTOMS.—This disease frequently comes on in a very insidious manner,—manifested only by a little soreness and stiffness in the joint after the exercise of the day. These symptoms, after a short period of rest, subside, and the patient is able to resume the use of the limb; but they return, and gradually increase in severity, and are attended with swelling. The swelling first makes its appearance at those portions of the articulation where the least resistance is encountered,—namely, in front of and between the malleoli and the extensor tendons of the foot. Later, the depressions on either side of the tendo Achillis and behind the malleoli are obliterated by the swelling, the leg becomes wasted, and the foot hangs in a helpless and expressionless manner, with the toes pointing downward. (Fig. 1065.) Flexion and extension, when attempted, cause uneasiness and pain. If the ligaments have participated in the disease, the lateral mobility of the joint is increased; and if abscesses have formed and opened, a probe can be

* *Chirurgical Society's Transactions*, vol. vi.

passed along the fistulous tracts into the joint, and may, perhaps, be brought into contact with dead or denuded bone.

When the enlargement is due to pulpy degeneration or fungous granulations, there will probably be neither abscesses nor sinuses present. In this condition all the characteristic features of the joint will be obliterated, the swelling will have a semi-elastic and doughy feel, and the skin will present a purple discoloration; or it may retain its natural color. In well-marked cases of this type, even when the cartilages have been eroded and the bones denuded, it is difficult to obtain any crepitus or grating, as the fungosities spread over the articular surfaces in such a manner as to prevent it.

When the disease begins as an osteitis or an epiphysitis, there will be noticed a marked enlargement or expansion of the bone, even before any material amount of swelling takes place.

DIAGNOSIS.—The morbid conditions with which disease of the ankle-joint may be confounded are inflammatory transudation of the sheaths of the tendons which pass to the foot behind the malleoli, and caries of the astragalus and the os calcis.

In the former of these two last-named affections the tenderness and swelling are confined to the course of these tendons,—i.e., to those portions of the joint behind the external and the internal malleolus; while in arthritis of the ankle-joint the swelling is first observed in front of the articulation. Extension and flexion are also more painful in the former than in the latter disease.

In caries of the astragalus the swelling is at some distance anterior to the tibio-tarsal joint, on the dorsal aspect of the foot; and when the disease is located in the calcaneum, the swelling is over the head. The sinuses which attend caries of these bones are usually situated over the parts affected. Those present in ankle-joint disease are closer to the malleoli.

As in all these inflammatory conditions the movements of the tibio-tarsal articulation are, by the reflex irritation of the muscles about the joint, diminished, it will be desirable, when any doubt remains as to the diagnosis, to administer an anæsthetic, in which case, if the articulation is free from disease, it will be found to move freely and without any grating or other abnormal sounds.

PROGNOSIS.—As in other joints, so in that of the ankle, when the arthritis is early detected and subjected to proper treatment, the disease may be resolved and the function of the joint preserved intact. When, however, the case has been neglected, and allowed to go on until the cartilages and ligaments have become necrosed, it may terminate in a cure by ankylosis, though too often the disorganization demands either excision or amputation.

TREATMENT.—Suspension of all motion and of all undue articular pressure is an indispensable condition in the treatment of chronic arthritis of an ankle-joint.

The foot should be placed at a right angle with the leg, and so maintained by a plaster roller, commencing at the foot, extending over the ankle, and continued up almost to the knee, the parts having been previously covered with a bandage or a very thin, neatly-fitting stocking. A high-soled shoe must next be placed on the sound foot, and the patient put on crutches. If the child is too young to use crutches, it should be kept in bed, or it can be carried about in the open air, and, when circumstances permit, it may ride out in a carriage. In cases of adults it is not necessary to use the high shoe, as the patient can be instructed to allow no weight to rest on the foot of the diseased limb. The great object is, in addition to fixing the joint, to prevent all forcible contact of the articular surfaces of the bones. As the swelling subsides, it will be necessary to renew the splint in order to follow up accurately the receding enlargement. For, should this be neglected, the joint will lie loose in the plaster shell, and consequently will not be entirely immobilized.

When abscesses exist, it will be necessary to cut traps in the splint, through

which the discharges can escape, and by means of which dressings can be applied.

When the joint becomes disorganized by suppuration and caries, there is little prospect that the case can be brought to a favorable termination without an operation. And this should not be too long delayed; for, if not controlled, the disease may extend beyond the limits of the tibio-astragaloid joint, and invade the bones of the tarsus, committing such structural ravages as to necessitate amputation of the foot. In anticipation of these consequences, it is better to remove the diseased bone from the articulation by gouging or by excision.

The operation of *gouging* is effected by enlarging one or more of the fistulous tracts, and carrying the openings through into the joint with a gouge or a scraper, the cutting parts of which should be somewhat *dull*, in order that no damage may be done to vessels during the operation. (Fig. 1066.) With

FIG. 1066.



Gouge and scraper.

these instruments the diseased portions of bone can be detached without destroying the investing periosteum. After this part of the operation, the débris should be washed out by injecting the joint with a stream of hot sublimated water.

A very expeditious mode of removing the diseased articular surfaces is by means of a burr (Fig. 1067) driven by a surgical engine. A free incision is made in order to expose the interior of the joint and to admit of the introduction of the burr, by which the bone can be cut away with the greatest rapidity and ease.

FIG. 1067.



Burr.

When the diseased bone has been removed, by whatever plan, and the débris washed out with the injection, a free drainage is next to be established by the rubber tubes, which must be well washed in sublimate solution before being used. In order to secure perfect drainage, it is best to have an opening on both sides of the articulation, so that the tube can be carried entirely across the joint or from side to side. This is very much better than to bury one end in the cavity of the wound and allow the other to remain out, as has sometimes been practiced, inasmuch as the drain or seton can be kept unobstructed.

As the antiseptic dressings become saturated with the discharges it is necessary that they should be renewed whenever the temperature begins to rise, usually in two or three days, after which the dressings should not be repeated oftener than is absolutely necessary.

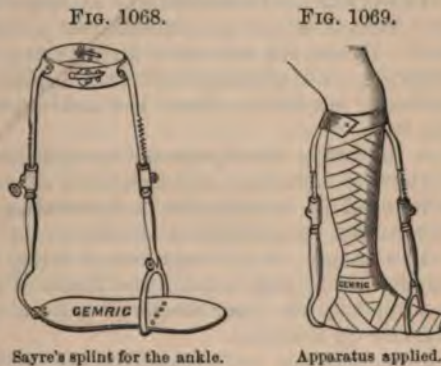
After the introduction of the drain, the foot should be placed at a right angle with the leg, and a plaster splint be applied, so as to secure the most perfect immobility of the joint. The *appareil* must have openings or traps

cut in it answering to the extremities of the seton, and through which the dressings can be made without disturbing the articulation. As the swelling about the ankle diminishes, it will be necessary to renew the plaster dressing or to remove it, and, after filling up the irregularities about the joint with oakum, to apply a roller and replace the splint. As soon as healthy granulations form,—which may be known by the diminution of the suppuration and the contraction of the sinuses,—the seton may be diminished in size, and finally dispensed with entirely, and the patient be allowed to move about on crutches, wearing a high-soled shoe on his sound foot. With the diminution of the suppuration and the contraction of the sinuses comes the necessity for gentle and cautious passive movements, with the view of securing a movable joint, as it by no means follows that the disease of a joint treated in this manner must necessarily terminate in ankylosis. Accordingly, flexion and extension may be made, very carefully at first, and only for a few moments; and if the joint does not resent the manipulation by becoming painful, hot, and swollen, or by an increase of pus, these movements may be renewed two days later. If they are still well tolerated, greater liberty may be taken in continuing the treatment.

Long after all internal manifestations of disease have disappeared, there will remain some inflammatory induration or thickening of the soft parts about the joint. This can be gradually got rid of by kneading, rubbing, the cold or the warm douche, and compression, either by adhesive plasters or by a flannel roller. The gum-elastic bandage may be used for the same purpose. Great caution will be required in resuming the use of the limb, that inflammation be not again excited. Indeed, several months should pass before the weight of the body is allowed to rest, in walking, on the affected limb.

Professor Sayre employs an apparatus by which, in the early stage of ankle-joint disease, before serious structural changes have occurred, it is thought the articular surfaces may be relieved from pressure during walking.

This instrument consists of a steel collar to surround the leg, a foot-piece to fit the sole of the foot, and two rods, each having a male and female screw, and connected with the band and the foot-piece,—the anterior rod by a hinge and stirrup. (Fig. 1068.) The limb is prepared for the apparatus by first placing longitudinally around the leg strips of adhesive plaster long enough to extend from the ankle to the tubercle of the tibia. These strips are additionally secured by covering them in with a roller, leaving about three inches of their upper extremities exposed. The band of the instrument is opened, slipped around the leg, and clasped, and the free ends of the adhesive strips turned over the collar and fixed by a roller. The foot at the same time is placed upon the foot-piece and made fast by adhesive plasters and a bandage. With a key the screws in the two rods are next turned, increasing the extension until the patient realizes the required support. (Fig. 1069.)



Sayre's splint for the ankle.

Apparatus applied.

Arthritis of the Calcaneo-Astragaloid and Astragalo-Scaphoid Joints.

This disease is often overlooked. It affects both children and young adults. It may have a strumous, a syphilitic, or a rheumatic origin. The exciting causes are concussion of the joint surfaces by falling upon the feet, and constant walking.

SYMPTOMS.—Pain is caused by forcible abduction or adduction of the affected

foot, or by pressing firmly upon the dorsum of the foot in front of the malleoli. The foot is markedly everted, and rigid, owing to the fact that the peroneal muscles are in a state of fixed contraction, and this gives an undue prominence to the internal ankle. So firmly is this malposition maintained that the surgeon may easily suppose the existence of ankylosis,—a condition which, in long-neglected cases, really does present itself. This had taken place in a young woman recently under my care, who had suffered from repeated attacks of the disease.

TREATMENT.—When early recognized, the affection is one which generally yields to treatment. Rest alone, in the recumbent position, for a few days, will resolve the spasm of the peroneal muscles and allow the foot to assume its natural position. As soon as this spontaneous reduction takes place, a plaster splint should be applied to the foot, ankle, and leg, and the patient placed upon crutches for eight or ten weeks, until the inflammatory state of the joints has disappeared.

If there is reason to believe that a rheumatic or syphilitic element is present, the use of iodide of potassium will be indicated; and when the constitutional manifestations of struma can be detected, cod-liver oil and iodide of iron should be administered.

Arthritis of the Tarso-Metatarsal Articulations.

Inflammation in these joints is not so often observed as in those which have already been considered.

The swelling which attends the disease may extend up as high as the ankle and render the diagnosis somewhat uncertain. By fixing, however, the ankle-joint, or by grasping the foot in front of the malleoli and holding it firmly with one hand while the tarso-metatarsal articulations are pressed together or put upon the strain with the other hand, the tenderness or pain consequent upon such tests may be referred to the proper joints. But it must be noted that, if neglected, after a short time the inflammation passes by continuity of structure to the other joints above.

TREATMENT.—Immobility is as important in the treatment of inflammatory disease of the tarso-metatarsal joints as in that of the other joints of the foot. Hence the necessity for covering the parts with a thin, neatly-fitting stocking, and placing over this a plaster roller extending from the toes to five or six inches above the ankle, and for rigidly interdicting any use of the foot.

A thorough inquiry should be instituted in every case of the disease, with a view to ascertain the existence of any dyscrasia which may have been influential in causing the inflammation. In the event of any such being recognized, constitutional treatment for its correction should be resorted to.

The danger, in all instances of tarsal arthritis, consists in the tendency of the disease to pass beyond the limits of the joint and to become an osteitis.

After two or three weeks of general rest, the patient may be allowed to exercise on crutches.

Arthritis of the Metatarso-Phalangeal Articulations.

Though any one of these joints may be attacked by inflammation, that of the great toe suffers most frequently.

The disease may arise from gout, rheumatism, scrofula, or syphilis, and—more frequently than other tarsal affections—from traumatic causes alone. The synovial membranes of the metatarso-phalangeal joints being independent of one another, there is little or no tendency in the inflammation of one to extend to another. The same may be said of the phalangeal articulations. If the gouty form of this disease prevails, there will be a tendency to a recurrence of the inflammation, and, after a time, to the deposit of the urate of soda, both within and without the joint, and eventually great distortion of the toes.

SYMPTOMS.—Upon the surgeon's grasping the metatarsal bone of the affected toe with one hand and its proximal phalanx with the fingers of the other, and pressing the articular surfaces together, or forcing the phalanx in different directions, the patient will complain of pain and tenderness. In some instances crepitus may be distinguished.

TREATMENT.—The treatment is the same as in arthritis of other tarsal joints, namely, *fixation* and *rest* by means of the plaster roller, which should include the foot, ankle, and lower part of the leg, in order to secure quiet to the flexor and extensor muscles of the great toe. When several of the toes are affected, and after the inflammation has been subdued by rest and immobility, though showing a tendency to recur on the use of the foot, advantage will be derived from wearing a shoe with a thick inside sole of cork extending only to the middle of the metatarsus. By this contrivance, in walking, the toes will be relieved from all pressure.

When the disease is gouty in its origin, it will be most expeditiously combated by a mercurial purge, followed by iodide of potassium conjoined with belladonna and colchicum.

Arthritis of the Occipito-Atloid and Atlo-Axoid Articulations.

Although disease of these joints does not materially differ from tuberculosis of other portions of the spine, yet, in consequence of the form and function of the atlas and axis, and the danger to life which attends inflammatory changes in their structure, it is proper to treat of them separately from other pieces of the spinal column. The extent of the movements—especially that of rotation—to which the head can be carried in virtue of the connections which exist between the atlas and the axis and the odontoid process and occipital bone, must necessarily allow a great strain on the ligamentous apparatus of the parts, and constitute an exciting cause of inflammation in the articulations or in their ligaments, particularly when the general conditions are present which predispose to disease. Whether the inflammatory process commences as a synovitis or as an osteitis, it usually proves to be very intractable in its course, destroying the ligaments to such an extent that the occipital bone may become displaced from the atlas, or, what is more common, the atlas may be displaced from the axis. The displacement is usually forward, and it may be followed by sudden death, in consequence of pressure on the upper part of the spinal cord. In cases of a chronic nature the displacement may occur so gradually, and be so associated with inflammatory changes, by which the diseased vertebrae, the ligaments, and even the membranes of the cord become blended together in a confused mass of connective tissue and callus, that, notwithstanding the space appropriated to the medulla spinalis within the ring of the atlas may be encroached upon, the pressure does not prove sufficient to suspend the functions of the cord, and the patient may not only live, but recover without paralysis, though exhibiting considerable deformity.

SYMPTOMS.—The disease commences with stiffness in the muscles of the neck, accompanied by dull, deep-seated pain and swelling in the back of the neck. The suffering is much increased by motion, which the patient is careful to avoid; and to prevent it when sitting up or moving about, he takes pains to steady the head by placing one hand under the chin and the other over the occiput; or, if compelled to direct the attention to one side or the other, he will turn the whole body instead of the head. Pressure on top of the head aggravates the pain. As the disease advances, the swelling extends as high up as the insertion of the muscles on the semicircular ridges of the occipital bone, and across from one mastoid bone to the other. The muscles become hard and rigid, owing to the inflammatory infiltration, the surface pitting on firm pressure.

When the forward displacement of the head commences, the deformity is more apparent; the spinous process of the axis, which normally is out of

sight and touch, becomes visible; the chin appears unusually advanced; deglutition is difficult and painful; pains extend to the shoulders and down the arms; swelling appears in the posterior wall of the pharynx, obstructing the posterior nares, spreading to the fauces, and causing difficulty of breathing, or even the protrusion of the tongue from the mouth.

Abscesses may open into the pharynx, or on the back of the neck, through the cavities of which fragments of necrosed bones may be discharged. When the spinal cord becomes compressed, either by inflammatory products or by the gliding forward of the head with the atlas, paralysis of the upper and afterwards of the lower extremities follows. Or asphyxia may suddenly occur from interruption of the respiratory process, consequent upon pressure on the medulla.

PROGNOSIS.—This affection, under any circumstances, must be regarded as fraught with great danger to the life of the patient. The gravity increases with the age of the patient. As long as no signs of paralysis are present, there will be reason to hope for recovery. But even the presence of paralysis is not incompatible with recovery, provided the medulla remains free from injury.

When the patient does recover, it is by ankylosis. The bones become solidly united together, leaving a permanently deformed and stiff neck.

DIAGNOSIS.—This disease in some of its features resembles cervical rheumatism and syphilitic necrosis of the atlas. In cervical rheumatism, however, there is no pharyngeal swelling. Neither is there deformity, nor any pain on the application of pressure to the top of the head.

In cases of syphilitic necrosis of the atlas, the bone disease is accompanied and often preceded by pharyngeal ulceration, and there is no prominence of the spinous process of the axis, even though a large part of the atlas may be discharged.

TREATMENT.—Rest and immobility are of the first importance in the treatment of this disease. And these can be secured only while the patient is in the recumbent position.

A piece of muslin must be cut so as to fit between the shoulders and to cover the back of the neck and the posterior part of the head. Over this two or three plaster rollers should be applied by recurrent turns, and the head and neck allowed to rest buried to some extent in a soft pillow. When the plaster becomes firmly set, the parts will have an equally distributed and safe support.

The position in bed must be enforced for a long time, or until ankylosis has taken place. Even after the patient is able to assume the erect position the head will for some time demand an artificial support similar to that employed in Pott's disease of the spine.

The appropriate constitutional treatment will consist in exhibiting cod liver oil and iron, with a generous diet, and also opiates when necessary to relieve pain.

Arthritis of the Sacro-Iliac Articulation.

This is not a common affection. It is met with generally in young adults, rarely, if ever, in children. Though noticed by Boyer and Chelius, the best descriptions of this disease have been given by Hahn, Nélaton, and Erichsen.

CAUSES.—The remote cause of this arthritis must be sought for in some specific constitutional predisposition, which, from exposure, exhaustion, or traumatic violence,—as when the pelvis has been subjected to severe compression, blows, or twists,—has been kindled into activity.

PATHOLOGY.—The inflammation most probably begins in the synovial membrane, and extends to the cartilaginous components of the joint. There are not, however, wanting facts which seem to show that an osteitis of the ilium or of the sacrum may precede all articular change.

As the disease progresses, the synovial membrane becomes thickened;

fungoid or pulpy granulations spring up in the joint; and these ultimately cause the utter disorganization of the articular cartilage, leaving the bones of the articulation uncovered, though without any marked tendency to either caries or necrosis. The ligaments also undergo a slow degeneration.

SYMPTOMS.—The commencement of the disease is announced by a sense of pain, weakness, or weariness experienced between the hips, and aggravated by standing, walking, or even sitting.

The pain is increased in coughing, sneezing, defecation, and urination, or in any straining efforts which call into play the muscles of the loins. It sometimes attains a great degree of severity, which will extort an outcry from the patient, particularly when the pelvis is twisted or when the ilium and the sacrum are pressed together. Walking gives rise to much uneasiness and to lameness, in which the body is advanced and the diseased limb favored as much as possible.

In standing, the posture is peculiar: the body is inclined over to the sound side, so as to relieve the affected joint from all pressure and to secure some extension by the weight of the extremity.

Swelling is an early symptom. It is at first seen in a line extending down from the posterior superior spinous process of the ilium, but not changing the form of the nates or the post-trochanteric depression. At a later period of the disease, however, and particularly when abscesses form, the swelling will extend to the buttock, materially altering its shape.

The length of the limb is also increased,—a condition due to a downward rotation of the innominate bone of the affected side, and not to any actual elongation of the limb. This will be made apparent by comparing the anterior superior spinous processes of the two innominate,—the one on the diseased side being on a lower plane than its fellow,—and also by measuring the distance between the same processes and the internal malleoli of the two ankles, which will be found to be the same in both extremities.

When suppuration is established,—an event which occurs at an advanced stage of the disease,—the diagnosis can be certified by introducing a probe through the opening, provided the abscess discharges externally, when the probe may be carried down directly to the denuded bone. It is not always the case that the pus finds its way externally; it may enter the pelvis and be discharged into the rectum and be passed per anum; or it may find its way through the sacro-schiatic foramen into the buttock; or, finally, it may descend between the obturator and the levator ani fasciæ, reach the ischio-rectal fossa, and appear as a fluctuating swelling at the side of the anus.

DIAGNOSIS.—There are several affections with which sacro-iliac arthritis may be confounded. These are coxalgia, sciatica, and caries of the spine or bones of the pelvis. The disease may be thus distinguished from coxalgia:

COXALGIA.

A disease chiefly confined to children under twelve years.

Pain generally at the knee or in the hip-joint.

Limb everted and abducted at first, and afterwards inverted and adducted.

Early change in the form of the buttock, and loss of the gluteo-femoral crease.

Movements of the limb restricted and painful, especially flexion and abduction.

No pain when the patient is turned upon his breast and the sacrum and ilium are pressed firmly together.

SACRO-ILIAC ARTHRITIS.

Mostly occurring in young adults.

Pain localized near the sacrum.

Limb only elongated.

No change in the form of the buttock, nor any obliteration of the gluteo-femoral crease, except in advanced stages of the disease.

Movements neither painful nor restricted when made with the patient in the recumbent position and with the pelvis fixed.

Pain severe under such treatment.

From sciatica, sacro-iliac arthritis may be distinguished by the following peculiarities:

SCIATICA.

Pain below the glutei muscles, and extending from the back of the thigh.
Often followed by contraction of the hamstring muscles and slight flexion of the leg.
No lengthening of the limb.
No deformity of the pelvis.
A disease generally of mature or advanced life.

SACRO-ILIAIC ARTHRITIS.

Pain above and posterior to the glutei muscles and does not extend down the limb.
No flexion of the leg.
Limb elongated.
Deformity of the pelvis.
A disease usually of young adults.

In distinguishing sacro-iliac arthritis from disease of the spine, the following comparison of symptoms may be drawn:

SPINE DISEASE.

Prominence of certain vertebrae, and antero-posterior curvature of some portion of the spine.
No elongation of the limb.
A disease generally of childhood.
In some cases pressure over diseased vertebrae causes pain.
Patient walks with the spine rigidly fixed and straight, and without limping.
In the event of an abscess forming and opening over or near the sacro-iliac synchondrosis, a flexible probe introduced into the opening will lead to the spine.

SACRO-ILIAIC ARTHRITIS.

Neither.
Elongation of the limb.
Occurring generally in early manhood.
Pain caused only by pressure over the sacro-iliac articulation.
Patient bends forward in walking, and is lame.
In abscess, the probe goes directly to the sacro-iliac joint.

Caries and necrosis of the innominate bone give rise to symptoms resembling in some particulars those of sacro-iliac arthritis, particularly when the posterior part of the ilium is involved. But the diagnosis may be reached by remembering that in disease of the ilium the patient is able to stand and walk for a long time without any unusual suffering; there is no tilting of the pelvis, no elongation of the limb on the affected side; and, when abscesses form and open on the surface and an exploration is made with the probe, the necrosed portion of the bone will be found in a position different from that of the articulation between the sacrum and the ilium.

PROGNOSIS.—Disease of the sacro-iliac articulation is generally fatal, the patient being worn out by long-continued suppuration and hectic fever. The fatality may depend on the fact that the true nature of the affection is often not recognized until extensive disorganization of the joint has taken place.

TREATMENT.—In order to relieve the affected wing of the pelvis from the evil effects of pressure and motion, the leg, the hip, and the pelvis should be encased in a plaster splint and the patient placed on crutches. At the same time he should wear a high-soled shoe on the foot of the sound limb, in order to prevent the weight of the body from resting at any time upon the diseased extremity.

When the pain is severe, it will be better to confine the patient to the recumbent position, and to apply extension to the limb by means of a weight attached to the leg by adhesive plasters.

When abscesses form, they must be opened freely, in order that the purulent accumulation may have a free escape; and when loose pieces of dead bone can be discovered, they should be promptly removed.

During the long and exhausting period of suppuration, the system will require to be sustained by a nourishing diet, and by the use of tonics,—both the bitter and the ferruginous,—together with cod-liver oil and stimulants.

Sterno-Clavicular and Acromio-Clavicular Arthritis.

These are not uncommon affections. Of the sterno-clavicular arthritis I have witnessed several examples. The disease is generally met with in young subjects, and often gives rise to so little inconvenience for a long time that the function of the joint is but slightly interfered with. An army officer who occasionally consults me has been suffering with this disease in the

sterno-clavicular joint for over twenty years, and, although the articulation is open and suppuration going on, he persists in using the arm.

SYMPTOMS.—When either of these joints is attacked by inflammation, there is swelling, partly due to the synovitis and partly to inflammatory transudation in the cellular tissue exterior to the articulation. Pain is felt on motion or on pressure. The end of the clavicle appears to be considerably enlarged, and is usually prominent. After a time suppuration occurs; and if the pus is not circumscribed by a wall of lymph, it may, when the sterno-clavicular joint is the seat of the disease, find its way into the anterior mediastinum; or, if the acromial end of the clavicle be affected, the pus may find its way into the neck or into the supra-scapular region.

In consequence of the magnitude of the interarticular cartilage and the size of the joint, the affection runs a very chronic course when seated at the sternal end of the clavicle. In time, however, if the inflammation be not controlled, the ends of the bone become carious, the ligaments soften and give way, and a *spontaneous luxation* follows.

TREATMENT.—When the nature of the disease is detected early, a cure may be effected either by resolution or by ankylosis,—though rarely by the latter. The shoulder being movable, it is very difficult to secure perfect fixation. Yet this must be obtained to the fullest extent possible, by a roller applied as in the Velpeau dressing for fractured clavicle. This, as a matter of comfort, should be alternated with a sling of the forearm, the arm at the same time being secured to the body by a strip of muslin.

Local applications do not seem to accomplish any very marked effects. Some benefit, I have thought, has followed the use of a plaster consisting of belladonna and iodoform and worn over the articulation.

If the disease follows an acute course, the interarticular cartilage and the ligaments may be so rapidly destroyed as to allow the end of the bone to become luxated. Under such circumstances the clavicle must be reduced, and treated as in traumatic luxation.

When necrosis supervenes and extends beyond the limits of the articular ends of the bone, at the same time exhibiting no tendency to separation, a resection of the diseased portion should be made. Between the opposing forces of the clavicular portion of the sterno-cleido-mastoid muscle above and the pectoralis major muscle below, and the restraint of the subclavius, the remaining part of the clavicle, when the arm is fixed, can be retained in a reasonably good position until it has contracted adhesions with the surrounding parts.

When the osteitis lingers for a long time at the articular end of the clavicle,—which may be determined by the use of the probe,—the scraper or gouge may be used with advantage, exercising due care not to disturb the costo-clavicular or coraco-clavicular ligaments, according as the sternal or the acromial end of the bone is under treatment. The preservation of these ligaments serves to retain the clavicle in its place.

Arthritis in Joints of the Upper Extremities.

Shoulder-Joint.—This articulation, though it resembles the hip-joint in its anatomical construction, is much less liable to disease of a strumous character. Both children and adults are the subjects of tubercular inflammation in the shoulder-joint,—the latter more frequently than the former. Commencing as a synovitis, the morbid action, unless early checked, extends to the head of the humerus, and it may also involve the glenoid cavity of the scapula. Even the coracoid process of the latter is sometimes destroyed, as was the case in a very estimable judge in Philadelphia, who recently died from this affection.

SYMPTOMS.—The disease generally commences with some soreness and stiffness of the joint,—at first usually regarded as rheumatic. The shoulder becomes swollen; and severe pain is felt whenever the humerus is crowded

against the scapula, sometimes extending down the arm in the course of the ulnar or musculo-spiral nerve, but oftener confined to the deltoid muscle. The muscles of the arm waste, and, unless the arthritis is soon arrested, supuration follows. This termination is announced by rigors, fever, and sweating. Pus, once formed, after a time finds its way out of the joint, sometimes following the course of the long tendon of the biceps muscle and opening on the surface of the arm below the anterior fold of the axilla, or, forcing its way through the softened capsule of the joint, it may pass beneath the deltoid muscle and be discharged either through the fissure between this muscle and the pectoralis major in front or posteriorly between the scapula and the shoulder.

DIAGNOSIS.—The disease under consideration bears some resemblance to rheumatoid arthritis and bursitis. From the first it may be distinguished thus:

STRUMOUS ARTHRITIS.

A disease of children and of young adults.
Head of the humerus remains unchanged in its position.
No crepitus; or if crepitation, a moist one.
Suppuration.
Rigors, fever, and sweating.

RHEUMATOID ARTHRITIS.

A disease of mature and advanced life.
Head of the humerus is raised and advanced forward; can be felt near the coracoid process.
Crepitation rough.
No suppuration.
No rigors, fever, or sweating.

The parts about the shoulder-joint which are prone to inflammation are the bursæ lying under the deltoid, and the tendons of the subscapularis and infra-spinatus muscles. As the last two communicate with the articulation, they generally become involved in all cases of strumous disease of the scapulo-humeral joint, by extension of the inflammation from the synovial membrane outward. When the disease is primarily a bursitis of these sacs, it will be found that pain is developed when the arm is drawn away from the scapula and at the same time rotated either inward or outward.

Forcing the articulating surfaces of the bones together, without rotation, does not cause pain in primary bursitis, but will do it in synovitis.

When the bursa between the humerus and the deltoid is inflamed, all movements of the arm, when it is allowed to hang by the side, will cause suffering. But when the limb is elevated, so as to relax the muscle, the humerus can be rotated or carried forward or backward without creating much uneasiness. Neither does forcing the head of the bone against the glenoid cavity of the scapula produce pain. These are tests that cannot be practiced in synovitis of the joint without causing complaint.

TREATMENT.—The treatment consists in flexing the forearm across the chest and bringing the arm to the side, after which the Velpeau bandage can be applied in order to secure entire quiet for the shoulder. When this dressing becomes irksome, it may be changed for a sling to support the forearm, the arm being fastened to the side by a roller bandage.

If, after the joint has been for some time in a state of repose, there is not a marked amelioration of the symptoms, a blister should be applied over the articulation.

After vesication, the cuticle may be to some extent removed and the surface sprinkled with morphia.

Should the disease run to suppuration, an early opening must be made and a free exit be provided for the pus, introducing, if necessary for this purpose, a drainage-tube. The patient, at this stage of the affection, will require a properly selected and nutritious diet, together with tonics,—as iodide of iron, tincture of sesquichloride of iron, quinine, and cod-liver oil, etc., with malt or alcoholic stimulants.

When the case results in caries and necrosis of the bones, and the strength of the patient begins to fail, our only resort is excision.

Elbow-Joint.—Strumous disease of the elbow-joint is, like that of the knee, protracted, and often very destructive to the components of the articulation.

The disease may commence as a synovitis or as an osteitis. When the latter, the humerus is generally first involved; and here the caries may linger for a long time before extending to the bones of the forearm; when the latter event does occur, the ulna is usually implicated rather than the radius.

SYMPTOMS.—The phenomena attending the disease are pain, swelling, flexion, and rigidity of the articulation. The swelling, at first, is most marked on the posterior aspect of the joint,—that is, on each side of the olecranon process of the ulna, extending also some distance above the latter,—points where the least structural resistance is encountered. After some time, however, all the bony prominences of the joint disappear, the swelling extending around the entire articulation, the skin at the same time becoming tense and shining. (Fig. 1070.) Both the arm and the forearm rapidly waste, and the least movement of the joint is attended with severe suffering.

FIG. 1070.



Strumous disease of the elbow-joint.

When suppuration takes place, the pus travels in the direction of least opposition, up the back of the arm underneath the triceps, and the abscess discharges on one side or the other of that muscle. The dense character of the intermuscular fascia, and its connection or expansion above the inner condyle of the humerus, favor evacuation on the opposite or external side of the triceps. Abscesses in front of the joint are not, as a rule, very common, and when they do occur it is in the more advanced stages of the disease, when they may find their way to the surface, generally on the outer side of the tendon of the biceps. This is due to the resistance of the bicipital aponeurosis on the inner side.

Sinuses, nevertheless, may form at all points about the articulation, determined very much by the inflammatory deposits in the extra-articular tissues. Sometimes they lead directly down to the diseased bone. At other times the passage may be a circuitous one. The humeral and olecranon epiphyses may exfoliate in their entirety. It would seem that in cases of this kind the inflammatory attack has been primarily located in the cartilaginous structure uniting the diaphysis with the epiphysis; for the exfoliated piece often exhibits no evidence of having participated in the caries.

TREATMENT.—Position and rest are the prime requisites in the treatment of strumous inflammation of the elbow-joint. The forearm should be flexed a little beyond a right angle with the arm, and placed midway between pronation and supination. The necessity for this latter position arises from the tendency of the radius to become displaced backward and upward,—an accident which would be favored by allowing the hand to fall, as it naturally does, into a state of pronation.

In order to maintain permanently this position of the limb, a splint should be accurately moulded to the arm, extending from the axilla to the metacarpophalangeal articulations. In no way can this object be better attained than by covering in the extremity with a spiral reversed bandage and afterwards adding the plaster rollers. These must be applied from below upward by circular turns, afterwards slitting up the dressing along the radial border of the forearm and the outer aspect of the arm; or the bandage may be applied, in

against the scapula, sometimes extending down the arm in the course of the ulnar or musculo-spiral nerve, but oftener confined to the deltoid muscle. The muscles of the arm waste, and, unless the arthritis is soon arrested, suppuration follows. This termination is announced by rigors, fever, and sweating. Pus, once formed, after a time finds its way out of the joint, sometimes following the course of the long tendon of the biceps muscle and opening on the surface of the arm below the anterior fold of the axilla, or, forcing its way through the softened capsule of the joint, it may pass beneath the deltoid muscle and be discharged either through the fissure between this muscle and the pectoralis major in front or posteriorly between the scapula and the shoulder.

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Elbow-Joint.—Strumous disease of the elbow-joint is, like that of the knee, protracted, and often very destructive to the components of the articulation.

of suppuration, or present an elastic feel, occasioned, in most instances, by the formation of fungous granulations within the joint.

When suppuration occurs, should the matter not find a ready outlet, a spontaneous luxation backward may follow. When the ligaments give way, the purulent matter is liable to travel up the arm, or downward into the hand, causing the most serious disorganization of the tissue.

TREATMENT.—The forearm and hand must be placed at rest, in order to secure complete immobilization of the wrist-joint. The support usually employed for this purpose, namely, a straight palmar splint, is not the best arrangement. It allows too much pronation of the hand, which increases the pressure of the carpal bones against the posterior radio-carpal ligaments. A better plan is to place the hand midway between pronation and supination, and, after applying a roller from the fingers to the elbow, to follow it with a plaster bandage, and afterwards to cut a trap over the back of the wrist, through which to inspect the joint or to make local applications. The forearm and hand, after being thus encased, should be placed across the chest and supported in a sling. As pressure is important, the same expedient may be resorted to as in arthritis of the elbow-joint, namely, the use of the rubber cloth placed between the splint and the first roller.

When the swelling is soft and fluctuating, the fluid should be removed by the aspirator, and the iodoform ointment should be freely applied to the surface of the joint. The surgeon must be ever on the watch for the diffusion of matter amidst the muscles of the arm or in the direction of the hand; and upon the earliest evidence of such an occurrence, he should open a way for its escape, afterwards keeping this way free by the use of drainage setons.

When sinuses form about an articulation, a favorable opportunity is furnished for an exploration of the joint, which can be done by the use of the probe.

Even though the articulating surfaces of the radius and ulna may be denuded, the condition is not incompatible with a cure by ankylosis.

When the carpal bones become carious, little hope remains of saving the hand; and the only choice left to the surgeon is that between excision and amputation.

Nervous Disease of Joints.

Pseudarthrosis.—This affection, sometimes called "*hysterical*," and by Mr. Paget "*nervous mimicry*," consists in an unnatural exaggeration of some functional disturbance of an articulation. Females are, in most instances, the subjects of this variety of joint trouble, and those belonging, for the most part, to the higher classes of society,—a fact which was long since pointed out by Sir Benjamin Brodie. It may exist in persons who are not at all hysterical and who are by no means lacking in an energetic will, and in persons both under and over puberty, but rarely does it occur in those beyond mature life.

The true character of this unreal disease is frequently not detected, and, to the discredit of the profession, the patient is often allowed to linger along for weary months, nursing her imaginary infirmity, and is sometimes subjected unnecessarily to leeching, blistering, and cauterization, and to an interminable succession of antispasmodics, until, perhaps, in a state of desperation, the medical attendant is displaced for some graceless charlatan, who dissolves the sham by the authoritative enforcement of a command. On the other hand, I have known the opposite error to be committed, and a patient seriously damaged by the use of violent measures to relieve a supposed functional condition of a joint, which in reality was an organic condition.

FIG. 1071.



Arthritis of the wrist.

SYMPTOMS.—A young woman, bred in luxury and indolence, and whose mind has been systematically occupied with subjects which appeal largely to the imagination, suddenly complains of pain in the knee or the hip. The articulation is rigidly fixed, and generally in the extended position. The joint becomes excessively sensitive, perhaps slightly swollen. The most delicate touch of a finger over the surface causes intense pain, and the slightest movement of the limb is followed by agonizing suffering. After some time, and in consequence of disuse, the circulation becomes sluggish, the extremity presents a bluish or mottled appearance, and the surface temperature falls below the normal standard, especially during the early part of the day. Towards evening the heat of the limb may be much increased. Except in very protracted cases there is little muscular or fatty atrophy of the part.

In some instances the symptoms exhibit a marked tendency to periodicity, —the pain coming on only at a particular part of the day, when it may continue for several hours, and then gradually subside. Notwithstanding the acute local suffering, there is an entire absence of fever. The appetite and general health are very little impaired.

In other cases we find this nervous condition in persons who neither by education nor by the exactions of social life have been rendered morbidly sensitive, but who, on the contrary, possess a more than ordinarily vigorous intellect and a marked independence of character. Such individuals are often endowed with a highly sympathetic nature, and will frequently compassionate the sufferings of others to a degree which makes them in a measure their own. I have seen a number of instances in which persons, both male and female, believed they had become the subjects of the diseases from which friends had died; describing all the symptoms which they experienced with a vividness which at once aroused a suspicion of their unreal character. Females, in great dread of cancer, have consulted me, complaining of intense pains shooting through the mammary gland, all of which disappeared on their being assured that there was not a trace of disease present.

CAUSES.—An attack of this form of joint disease can often be traced either to uterine displacements or to some derangement of the menstrual function. In three instances I have seen it occur in the hip from intra-pelvic cancer causing pressure upon the obturator nerve. Mr. Erichsen mentions a case of the disease arising from this cause. Often the cause appears to be purely psychological. It has occurred to me to meet with pseudarthritides oftenest in females with black hair and dark complexion, and in whom the capillary circulation was sluggish.

DIAGNOSIS.—The diseases with which pseudarthritides, or "hysterical" joint-disease, is liable to be confounded are *arthritis*, *coxalgia*, *white swelling*, and *feigned articular disease*.

Pseudarthritides may be distinguished from arthritis by attending to the following considerations:

PSEUDARTHRITIS.

Generally seen in females.
Joint slightly or not at all swollen.
Without redness.
Greater tenderness complained of from a slight touch than when the part is firmly pressed upon.
Pain superficial.
Manifestations of pain overstated.
Limb remains unchanged.
Temperature under rather than over the natural degree.
Attack sudden.
Flexion of the limb occasionally present.
Twitchings of the muscles sometimes present, though not attended by any increase of pain; and always ceasing as the patient falls asleep.
No constitutional disturbance.

ARTHRITIS.

Seen in males and females with nearly equal frequency.
Marked swelling of the joint.
Often with redness.
Pressure painful only when firm.
Pain deep-seated.
Not exaggerated.
Limb wastes.
Temperature over the normal standard.
Attack usually gradual.
Flexion always present.
Spasms or starts of the muscles of the limb entailing acute pain at the time, and often occurring as the patient falls into sleep.
Constitutional disturbance generally present.

From coxalgia and white swelling pseudarthrititis may be distinguished without difficulty.

PSEUDARTHRITIS.

Sudden in its attacks.
Pain diffused.

Nutrition of the limb but little, if at all, impaired; the surface never shining and polished.
External features of the joint unchanged.

Crowding together the joint surfaces causes no pain.
Direction or attitude of the limb but little, if at all, changed.

No tendency to suppuration.

HIP AND KNEE-JOINT DISEASE.

Gradual in development.
Pain localized, and generally at the inner side of the knee, in both hip and knee-joint disease.
Limb wasted.

Flattening of the buttocks, and obliteration of the gluteo-femoral crease, in hip disease; disappearance of the depression on each side of the patella, in knee-joint disease.

Causes pain.

Limb flexed, abducted, and rotated outward in the first stage of coxalgia; and the knee flexed in white swelling.

Frequently abscesses, both external and internal to the joint.

Anæsthetics may be used with great advantage in clearing up obscure cases of joint affections. When the will is rendered incapable of influencing the muscles, the movements of the articulation, in the absence of disease, will be free and unrestrained.

The hot iron brought in close contact with the affected limb will often reveal the true nature of the case, when the disease is unreal, by the quickness with which the part is withdrawn and moved about, without any cry or scream referable to pain.

TREATMENT.—A careful examination should be instituted in all cases of pseudarthrititis, with a view to ascertain if there is any *material* explanation for the condition. If there is leucorrhœa, dysmenorrhœa, or endometritis, it should be corrected by proper remedies. In the event of uterine displacement, the malposition must be rectified.

If the patient is anæmic and the general health is deteriorated, iron conjoined with antispasmodics should be given. The best combination, according to my experience, is valerianate of iron with asafetida, and bromide of camphor. The shower-bath, or sea-bathing, will often be found a valuable adjuvant to the treatment.

The proper local remedies are massage, manipulation, and electro-galvanism.

The patient must be encouraged to use the limb systematically, say two or three times each day, at a given hour, and every day to increase the exercise, receiving some encouraging words for every voluntary effort put forth, until, by degrees, the usual functions of the limb are restored.

It will not do to let the patient understand that the malady is deemed an unreal one. Such a course will fail to secure that confidence which so largely contributes to the success of the treatment. The effect of proper mental impressions cannot be over-estimated in the management of this singular form of joint disturbance. And on this account it may be necessary to remove the patient from her friends, in order that an entirely new direction may be given to the thoughts, and that the demoralizing influence of unwise sympathy may be avoided.

CHAPTER XVI.

EXCISION OF JOINTS AND BONES.

Excision, sometimes designated *resection*, may be executed in the continuity or in the contiguity of bones,—that is, at any point respectively between or through their articulating extremities.

Excision in continuity is a very ancient operation. References are made by ancient writers to this mode of dealing with caries, as also with diseased joints, and with the broken ends of bones in compound fractures, when protruding through the external wound. In the last-named cases, Hippocrates advised that the protruding ends, when not reducible, should be cut off. The instructions of Celsus and Albucasis are to the same effect. Paulus Ægineta recommended the removal of entire bones, like the radius and the ulna, when diseased, and speaks of the propriety of cutting away portions of osseous tissue near to an articulation. Fabricius Hildanus, in 1670, removed the astragalus for a compound luxation of that bone.

The first resection appears to have been performed by Cooper, of Bungay, England, in 1750. The lower articular extremities of the radius and the ulna were removed by this surgeon. About the same time, Dr. Schlichting reported the removal of the head of the femur from a patient suffering from hip disease. In 1758, Wainman, of Skipton-in-Craven, in a case of compound luxation of the elbow-joint, excised the condyles of the humerus with a successful result. In this case the patient owed the preservation of his arm to the unwillingness of the family to have it amputated. Four years later (1762), Mr. Filkin, of Northwich, unable to secure the consent of the patient's friends to an amputation, removed the articulating ends of the femur and the tibia, together with the patella, for disease of the knee-joint. Mr. Filkin had evidently been contemplating the excision of diseased joints, as he had previously performed the operation on the dead body. In the same year, Bagieu, of France, executed a partial excision of the wrist. In 1767, Vigaroux, of Montpellier, excised the head of the humerus, and about the same time a similar operation was executed by David.

During the succeeding ten years excisions of the upper extremity of the humerus and of the elbow were performed for caries,—one in 1768, by White, of Manchester; one in 1771, by Mr. Bent, of Newcastle; one in 1778, by Mr. Ored, of Chester; and one in 1775, of the elbow, by Justamond. The success attending these operations had no small influence in extending the practice of excision to other articulations.

In 1781, Mr. Park, of Liverpool, successfully excised the knee-joint of a Scotch sailor, thirty-three years of age, who had been suffering for ten years. On June 20, 1782, the same surgeon repeated this operation on a man thirty years old, but with an unfavorable result, the patient dying on the 13th of the ensuing October. The subject of treating joint disease by a more conservative plan than that by amputation had been with Mr. Park (as his letter to Percival Pott clearly shows) a matter of serious consideration long before he executed this operation. He had demonstrated upon the cadaver the feasibility of excising both the knee and the elbow articulation, and had fully weighed all the difficulties attending the operation, and also the probable utility of the limb, if successful. The views of Mr. Park as to excision, and the results of his two published cases, appear to have attracted very little attention from the British profession, as we learn that during the

long and bloody war which succeeded their publication not a single excision was performed by either the naval or the military surgeons of the realm. In 1784 Mr. Park's observations were translated into French by Professor Lassus, and it is thought that to this circumstance may be attributed the interest taken in the subject by the Moreaus. This, however, is very improbable, as the elder Moreau had in 1782, two years previous to the publication of Park's paper in France, successfully removed the lower extremities of the tibia and fibula on account of caries, in a case the history of which had been communicated to the Academy of Surgery in Paris.

In 1786 the elder Moreau removed the shoulder-joint, and in 1792 the elbow-joint. Subsequently, he and his son at different times excised the shoulder-, the knee-, the ankle-, and the wrist-joint. Between this time and 1794 followed the operations of Sommeillier, Larrey, Percy, and Willaume, on the shoulder. Mulder, of Groningen, who, after White, had advocated the applicability of the operation to the head of the femur, in 1809 excised the knee. The operations of Roux in 1819, and of Sir Philip Crampton in 1823, on the elbow-joint, were in 1825 succeeded by those of Syme, of Edinburgh, Bilguer, of Germany, and Hey, of Leeds.

The publication of Mr. Syme's fourteen cases of excision of the elbow-joint exerted no small influence in awakening a new interest in this subject,—an interest which was increased by the operations of Textor, Heyfelder, Liston, and Fergusson, especially the latter.

CONDITIONS REQUIRING EXCISIONS IN THE CONTINUITY OF BONES.—1. In compound fractures where the ends of the fragments project through the external wound and cannot be replaced by the usual methods employed for reduction.

2. In ununited fractures, after other and safer means have failed to secure consolidation.

3. In cases of vicious union after fracture it may be necessary to remove a portion of the bone in order to correct deformity.

4. A bone may be comminuted by shot or other violence and require partial excision.

5. In caries and necrosis it is frequently necessary to excise the diseased bone.

6. In cases of extreme bending of bones following rickets a partial excision may be demanded.

CONDITIONS REQUIRING EXCISIONS IN CONTIGUITY.—1. In many cases of compound luxations before reducing the articulating ends of the bones.

2. In caries of joints without any tendency to ankylosis, and in which the suppuration and the resulting constitutional irritation are making serious inroads on the general health of the patient.

3. In badly-communited fractures, involving the articulating extremities of the bones, without lesion of the principal blood-vessels or too extensive destruction of the surrounding soft parts.

4. Occasionally in ankylosis, with great deformity of the limb.

5. In old unreduced luxations, in which the head of the bone, by pressure on important nerves, occasions much pain and disability.

6. In cases of varus or valgus in the adult, not correctible by ordinary measures, portions of the tarsus may be excised.

7. Occasionally in genu valgum.

CONDITIONS CONTRA-INDICATING EXCISIONS.—1. When so much of a bone is diseased that its removal would render the limb useless for support or prehension, it will be better to amputate. In the upper extremity a much larger amount of bone can be excised without impairing the use of the limb than in the lower.

2. When the joint surfaces are involved in malignant disease, it is better to amputate.

3. When the health of the patient is greatly impaired by previous disease, and consequently the body rendered incapable of resisting the exhaustion

attending a protracted suppuration. Especially is excision contra-indicated if there are present the physical evidences of tubercular disease of the lungs or disease of the kidneys. If, however, the general health appears to be slowly yielding to the local irritation, pain, and suppuration which are incident to the disease, the operation will not be contra-indicated.

4. In patients very young, or in those past mature life, and if also the articulation belongs to the lower extremity. The reparative resources of early childhood are very great and very active, and it is difficult to fix limits to the possibilities of spontaneous cure in this class by ankylosis, exfoliation, or resolution. There is another condition which makes it undesirable to cut away the epiphyses of young bones: the operation puts an end to the growth of the limb in length.

5. During the presence of acute inflammation or abscess in a joint, or when the system is perturbed by traumatic fever, the prospects of success being greatly enhanced by allowing the disease to become *chronic* before any operative interference is attempted. The plastic infiltration, which extends into the tissues some distance beyond the seat of the disease, presents a barrier against the formation of diffuse abscesses and the intrusion of the products of tissue-change into the system. Patients who have been the subjects of chronic joint or bone disease for a considerable length of time acquire a wonderful tolerance of cutting operations.

6. When there is a tendency to ankylosis the knife must be withheld.

7. When, in addition to articular disease, there are present symptoms of osteo-myelitis, which, of course, would make the excision valueless, amputation should be substituted.

8. When the inflammatory action, or caries in the joint surfaces of the bones, is rapidly extending,—a state of things usually associated with a deeply-implanted strumous vice of the system, unfavorable to the operation.

REPARATION FOLLOWING EXCISION.—When a portion of bone is excised, or when a joint is resected, their opposite extremities may come together and unite by the interposition of callus. When the interspace resulting from the excision is great, or when the ends of the bone or bones are kept some distance asunder, the gap is not bridged over by new bone, but is occupied by fibrous tissue, which, from the mobility of the parts, in time acquires great thickness, density, and strength.

If, however, in excising bones, in either their continuity or their contiguity, the periosteum is preserved, a certain amount of new bone may be obtained to take the place of the portion removed. The experiments of Troja and Syme, and, more recently, those of Ollier, and my own,* establish beyond all controversy the osteogenetic properties of the periosteum. The extent to which this membrane is capable of effecting repair will depend on its density and form. If, previous to an operation on a diseased bone, the periosteum is found thickened and readily separated in its entirety, possessing at the same time sufficient resistance to maintain its form, it will with great certainty supply a new bone. In a case of phosphorous necrosis of the inferior maxillary, in which the entire bone was shelled out by Dr. William Hunt, the jaw was restored almost to its primal perfection. Other examples of a similar kind have been furnished by writers. I have seen the entire clavicle reproduced.

When, however, the periosteum is thin, and, after detachment, its surfaces are allowed to fall together, no orderly reproduction of osseous matter, so far as my observation extends, may be looked for. Any new bone which in such a case does appear is deposited in little, disconnected masses, rather than in a continuous and firmly-constructed piece.

It is chiefly in the long bones that we may expect to find this reparative work of the periosteum, though it is occasionally witnessed after subperiosteal excision of the short or irregular bones. To secure the full bone-producing operation of the periosteum, Sédillot advocates an operation which

* Address on Repair of Bone, delivered before the Philadelphia County Medical Society.

he styles "*l'évidement des os*," which consists in gouging out the osseous tissue, leaving only a thin shell covered with its investing membrane.

Another matter of paramount importance in an excisional operation is its influence on the subsequent development or growth of the bone. Bones grow in length through the agency of a plate of cartilage interposed between the diaphysis and the epiphysis. Should the whole of the epiphysis be removed, there is an end to the further longitudinal growth of the bone so far as the excised extremity is concerned. Consequently, the diseased limb cannot keep pace with the development of the other. It might be supposed that, when an operation of this nature becomes necessary, the epiphysis at the other extremity of the bone would, under the law of necessity, be stimulated to increased activity and thereby compensate for the loss of its fellow. But it must not be forgotten that the upper and lower epiphyses of the long bones are not equally concerned in the work of development. In the femur and in the radius, for example, the longitudinal growth is principally effected by the *lower* epiphysis; while in the leg and the arm it is chiefly accomplished at the upper epiphysis of the tibia and the humerus.

When the skeleton has attained its full growth, and the diaphysis and epiphysis become blended into a single piece, as is usually the case after the twentieth year of age, any excision performed can shorten the limb only in proportion to the thickness of the piece removed.

INSTRUMENTS REQUIRED FOR EXCISION.—The instruments necessary for resecting bones are the following: an ordinary *scalpel*, with which to make the

FIG. 1072.



Periosteal elevator.

preliminary incisions for the exposure of the bone or the joint; a pair of *forceps*, to aid in the dissection of flaps; a *tourniquet*, to control hemorrhage; two strong *bistouries*, with short blades, one sharp and the other probe-pointed,

FIG. 1073.



Retractors.

to be used, respectively, in dividing ligaments and in shaving the muscles away from the bone; a narrow *periosteal elevator* (Figs. 1072, 1075); *retractors*, to hold the sides of the wounds apart (Fig. 1073); a *shield*, consisting

FIG. 1074.



Bone director.

of a piece of soft wood or a strip of hammered sole leather, designed to be passed between the bones and the soft parts, in order to protect the latter from injury during the use of the saw; and a *bone director* (Fig. 1074).

To divide the bone a number of saws should be at hand. Mr. Butcher has constructed one which bears his name (Fig. 1076), and which is admirably

FIG. 1075.



Narrow periosteal elevator.

adapted for this purpose by its narrow blade, which can be made to cut in any direction, and enables the operator to make the section at any degree

FIG. 1076.



Butcher's saw.

of obliquity. It will be desirable also to have a *chain-saw* (Fig. 1077), a *metacarpal saw* (Fig. 1078), and a *semicircular saw* (Fig. 1079).

FIG. 1077.



Chain-saw.

FIG. 1078.



Metacarpal saw.

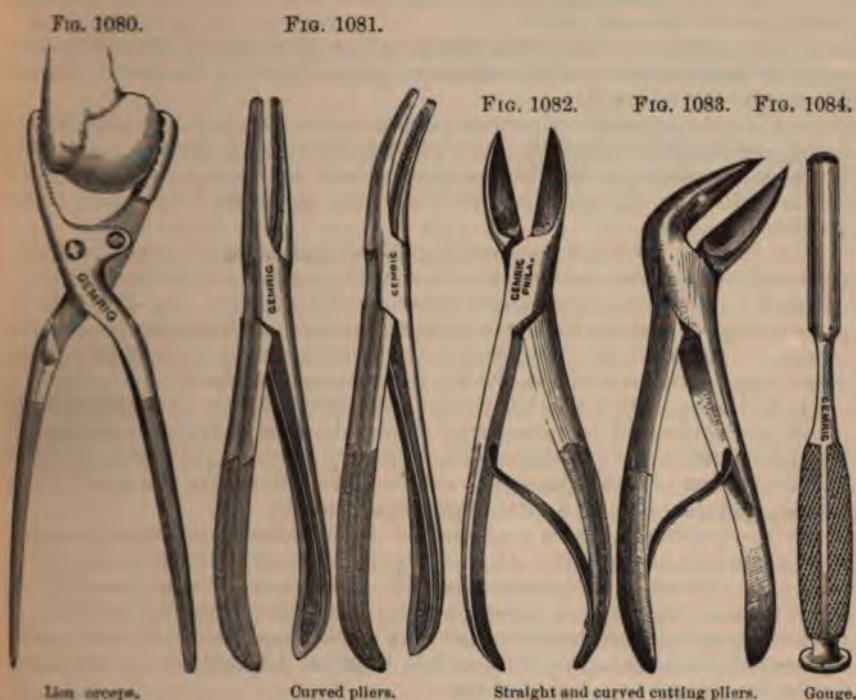
FIG. 1079.



Semicircular saw.

In addition to these instruments, there will be required a pair of strong *lion forceps* (Fig. 1080); straight and curved *forceps* (Fig. 1081), which can be used to steady the bone during its division; *cutting pliers*, straight and curved (Figs. 1082, 1083), and a *gouge* (Fig. 1084),—the former for cutting away

either the articular ends of bones or projecting spiculæ, and the latter for gouging out any portions of osseous tissue which may not be altogether sound.



RULES TO BE OBSERVED IN EXCISIONS.—It is impossible, of course, to include in these rules every detail attending an excision. But general directions can be given which will serve to govern these operations.

1. The patient, with few exceptions, should be placed in the recumbent position and be put under an anæsthetic.

2. When a major joint is to be excised, there should be at least four assistants present,—one to administer the anæsthetic, two to support the limb, and the fourth to sponge the wound, hand instruments, and aid in the ligature of vessels.

3. A tourniquet must be placed loosely about the limb when it is feasible, and tightened in the event of the bleeding becoming profuse.

The Eschmarch elastic bandage, though it renders the operation bloodless, is always followed by so much bleeding after its removal that I am not partial to its use.

4. The incision should be planned so as to give the fullest exposure of the articulation, at the same time disturbing as little as possible the tendinous attachment of muscles, and avoiding important blood-vessels and nerves in the vicinity of the joint.

5. The bones should be thoroughly isolated from all their surrounding connections, and should be generally pushed through the external wound before being cut off by the saw, the deep parts being protected by the interposition of the leather or wooden shield.

When the chain-saw is employed, it may not be necessary to bring the bones out before their division.

6. No more bone should be removed than is necessary to include the disease; and in children the section should not include the whole of the epiphysis, otherwise the longitudinal growth of the limb will be arrested. In cases of

adults, where such a precaution is not necessary, it is, nevertheless, desirable not to trench upon the medullary canal, as the risk both of caries and of constitutional infection is thereby increased.

7. When two bones parallel with each other are to be removed, they should be divided on the same level.

8. The excision of the articulating extremities should always be made beyond the attachment of the capsular ligaments, as the danger of inflammation is thereby lessened.

9. It is not necessary to remove portions of bone which are studded with rough and irregular osteophytes, or which are somewhat rarefied and softened by their proximity to the diseased part. Such portions, when no longer in contact with the disorganized articular ends, generally return to a healthy condition.

10. After the arrest of hemorrhage, the wound must be freed from blood-clots and foreign material by being thoroughly washed out, either by a shower of tepid water from a sponge or by the use of a syringe. Its edges are next to be brought together by the interrupted suture, a drainage-tube or a twist of oakum having been previously introduced, so as to secure at the most dependent part a free escape of all inflammatory products.

11. If the operation has been done antiseptically, the antiseptic dressing in all its details will be necessary; if not, the part may be enveloped in a laudanum-and-water dressing and covered in loosely by the turns of a roller. The limb must next be placed in a splint which will secure the utmost quiet; nothing answers so well for this purpose as plaster.

12. The position must be that which it is desirable to maintain throughout the subsequent treatment. As it is important, in excisions of the joints of the upper extremity, to preserve motion at the seat of the operation, after the inflammatory stage is passed, passive movements will be required. At the knee and the ankle, however, the limb will be most useful when the excised surfaces of the bones are solidly united together by new bone; and hence it would be improper to disturb them.

13. The constitutional treatment necessary after excision consists in relieving pain and controlling muscular spasms by opiates, given either by the mouth or hypodermically. Synovial fever will be best relieved by the employment of the neutral mixture; and, when suppuration sets in, the system must be supported by a good diet, tonics, and, perhaps, stimulants.

14. When the wound refuses to heal, there will be ground for concluding either that all the diseased bone was not removed, or that the disease has commenced anew. Should abscesses form, followed by sinuses which refuse to close, the probabilities of a renewal of the caries will be increased.

Under these circumstances a second excision is allowable, in case it does not necessitate too great a loss of bone, in which event amputation may be preferable.

EXCISION OF SPECIAL JOINTS AND BONES.

Excision of the Shoulder-Joint.—Excision of the shoulder-joint may become necessary in consequence of gunshot injuries or of caries of the head of the humerus; from fractures attended with comminution; and in cases of old luxations, in which the bone presses injuriously upon the axillary nerves. It may also be required after an intracapsular fracture, in which the head of the bone, lying loose in the joint, gives rise to abscesses. In 1869, Professor Warren, of Baltimore, performed successfully an operation of this nature. In a large majority of cases wherein excision has been performed at this articulation for disease, only the head of the humerus has been removed, the glenoid cavity not participating in the caries or necrosis. The same is true when the operation has been done for shot injury. Extirpation of the shoulder-joint has been practiced for malignant disease, and for bony tumors involving the upper extremity of the humerus. Excision for carcinoma is

not proper. When an operation for a disease of this nature is demanded, it should be amputation.

OPERATION.—The operation may be divided into three stages: first, the exposure of the head of the humerus; second, the separation of its attachments; and, third, its removal.

Exposure.—The patient having been etherized, and the affected shoulder brought over the edge of the table, a straight incision, five inches in length, should be made, commencing at the acromion process of the scapula, and carried vertically down the arm, extending through the integument and the belly of the deltoid muscle directly down to the capsular ligament and the bone. By this method the fewest fasciculi of the muscle are severed,—a matter of much importance.

Any vessels which spring must now be secured. Generally two or three branches of the circumflex artery will require a thread.

Drawing the sides of the wound well asunder, the muscle should be next separated, by a few touches of the knife, from its cellular connections with the capsular ligament of the joint. This will give a better exposure of the parts. The arm is now to be carried close to the side, and pushed upward, in order to stretch the capsular ligament over the head of the bone. The bone must now be divided. If the operation is to be performed for chronic disease of the joint, the ligaments may be found completely disorganized.

The second stage consists in liberating the head and neck of the humerus and enabling the operator to thrust the bone through the external wound. This can be done in two ways,—either by direct division or by the subperiosteal method of Ollier.

In the first plan the tendons of the scapular muscles are cut through at their attachments to the greater and lesser tuberosities of the humerus. This is readily accomplished by placing these structures on the stretch, by first rotating the arm strongly inward (which will facilitate the division of the tendons of the supra-spinatus, infra-spinatus, and teres minor muscles), and afterwards rotating it outward (which brings into view the attachment of the subscapularis muscle), after which the head of the humerus can be forced through the external opening in the soft parts. The tendon of the biceps muscle must be preserved entire, by being dissected out of its sheath and held out of the way.

The other method requires for its execution, after opening the capsule, an elevator, by which the ligaments with the periosteum and the tendinous insertions of the muscles can be separated from the bone to the extent of the disease. This last plan, though not so quickly accomplished as the first, has the advantage, when successfully executed, of restoring to some extent the removed bone and its muscular connections, and consequently, when the patient recovers, there are less shortening and a better command of the arm.

The third stage of the operation consists in removing the head of the bone. In doing this the arm should be carried either backward or forward, in order to direct the head and neck of the bone externally. The sides of the wound must be held apart by the retractors; and to protect the deep-seated parts from damage the wooden or leather shield must be interposed between the latter and the bone while the diseased portion is divided by the saw. (Fig. 1085.)

Should the glenoid cavity be found to participate in the disease, it must be treated either by gouging or by excision. The curved cutting pliers can be used with advantage for this latter purpose.

After the diseased bone has been removed and all vessels requiring ligature have been secured, the wound must be thoroughly cleansed, and its sides brought together by the interrupted suture, a rubber tube having been previously introduced and brought out at both extremities of the wound, so as to secure free drainage.

The shoulder is then well washed with the sublimate solution, and, if the

dressing is done antiseptically, is covered with carbolated or sublimated gauze and absorbent cotton, over which is to be applied loosely a spica roller.

FIG. 1085.



Excision of the shoulder-joint.

Finally, the arm is brought to the side, with the forearm flexed across the chest, and supported in a sling, a wedge-shaped pad having been previously placed in the axilla, to keep the humerus out from the body. This sling should not only support the arm, but raise it up towards the scapula, so as to favor the shortening of the muscles, and, consequently, to bring the humerus nearer to the glenoid cavity,—a position favorable to the future power and usefulness of the limb.

Usefulness of the Arm.—After recovery, in successful cases, the arm can be moved forward, backward, and to the side with great ease and with considerable power, and is capable of carrying heavy weights, even where as much as five inches of the bone have been removed. Except in the flattening of the deltoid, the shoulder is very little changed in appearance. Flexion, extension, and rotation of the forearm are but slightly impaired, while all the functions of the hand can be executed with a completeness little inferior to that of its fellow.

The movement most defective is that of abduction. The arm can rarely be elevated beyond a right angle with the body. This is due to the disadvantage at which the deltoid acts. But in one instance, narrated in the "Surgery of the War,"—that of a private in a New York cavalry regiment, wounded by a shell, in the shoulder, at Culpeper,—the head and five inches of the humerus were excised, and yet after the recovery of the patient he was able to place the hand of the injured arm on the top of his head, and carry weight amounting to two hundred pounds.

Even in cases where, on account of the amount of bone removed, the arm hangs limp and weak by the side, the fact that the forearm and the hand remain capable of executing multiform prehensile acts is a compensation which no human mechanism can approach. Nine times during our late war as much as 7 or 8 inches of the humerus were excised; twenty-three times, 4 inches; eleven times, 4½ inches; and seven times, 5 inches, without seriously impairing the functions of the arm.

Shape of incisions.—There are quite a number of different-shaped incisions practiced by different surgeons for exposing the joint. White, Bellamy, MacCormac, Larrey, Gross, Bryant, and Langenbeck adopt the longitudinal,—the one which I have found to answer the purpose, and which inflicts the least injury on the deltoid. Pancoast advises an S-shaped incision. Moreau made two longitudinal incisions,—one in front of and one behind the deltoid muscle,—uniting these by a transverse cut made below the acromion process. This operation not only endangers the cephalic vein in front, but necessarily cripples the deltoid by its extensive division. Sabatier, Wattman, and Hamilton prefer a V-shaped incision. Morel, Fergusson, Bell, and Stromeyer adopted the semilunar flaps, with the convexity downward; and Erichsen and Gant make their incisions U-shaped. Others, like Syme, preferred an

L-shaped cut; or, with Bouzaires, a Y-shaped; and others again, a T-shaped, as practiced by Bent.

HISTORY OF EXCISION OF THE SHOULDER-JOINT.—Excisions of the scapulo-humeral joint, more or less complete, on account of disease, were very early performed. The earliest of which we have any record was done in 1740, by Thomas, of Pézénas, in Languedoc, for necrosis of the head and upper part of the shaft of the humerus; and in 1767 operations somewhat similar were done by the French surgeons Vigaroux, of Montpellier, and David, of Rouen.

The first excision of the scapulo-humeral joint for shot injuries appears to have been done by a French surgeon named Grosbois, in 1796, on the person of a corporal wounded at Roveredo; and the second instance of a similar operation is attributed to M. Poret, in 1809. Operations for comminuted gunshot fractures of the upper end of the humerus were executed by Boucher in 1745, by Larrey, during Napoleon's wars, as early as 1793, and by Guthrie in 1812. In many of these cases of disease and shot injury the excision consisted in enlarging existing sinuses or wounds and extracting the exfoliated or broken pieces of bone. The first deliberately-planned excision of the shoulder-joint was done by White, of Manchester, in 1768, for necrosis. The operation was limited to the upper extremity of the humerus. Moreau the elder made the first *complete excision*, having cut away the head of the humerus, the glenoid cavity, and a part of the acromion process of the scapula. In the interval between White's and Moreau's operations a number of partial excisions for disease were performed,—one, in 1770, by Ridewald, for rheumatoid arthritis, and in the following year one by Bent and one by Lenton, both for necrosis. The last was particularly worthy of note, as the entire humerus was removed, except about two inches of its lower extremity. Baron Percy, as early as 1794, is said to have exhibited, in Paris, nine cases of excision of the head of the humerus. And there can be no doubt that Larrey, in a number of instances of shot fractures detaching the shaft from the head, extracted the latter by an incision through the deltoid.

In this country, the first excision of the scapulo-humeral joint for gunshot injury was performed by William Ingalls, of Boston, Massachusetts, in 1813. Succeeding this were the operations of Brown, Walker, Mann, Hunt, and McCook, in 1814. In 1826 the last-named surgeon did the same operation for disease of the bone.

Hennen, as late as 1820, in speaking on this subject, used the following language: "I am disposed to think that the excision of the head of the humerus will be found to be more imposing in the closet than generally applicable in the field." The experience, however, of English, Continental, and American military surgeons has established the operation on a solid foundation of facts, which renders its propriety under certain circumstances unassailable.

Dr. Hodges has tabulated 475 cases of excision at the shoulder-joint for shot wounds, 252 being primary and 223 secondary operations. The mortality of the first was 23 per cent., and that of the second 38 per cent. The same author has collected 50 cases of excision at the shoulder-joint for disease, 42 of whom recovered and 8 died. Of those tabulated as "recovered," 2 subsequently died from consumption of the lungs, and 2 were not benefited by the operation. These facts increase the mortality to 16 per cent.

Dr. S. W. Gross analyzed 749 cases of scapulo-humeral excision for shot injury, 498 of which recovered and 251 died,—giving a mortality of 33.51 per cent. Of these excisions, 285 were primary and 379 secondary, with 143 deaths.

Dr. Culbertson, in his prize essay entitled "Excision of the Larger Joints of the Extremities," analyzes 983 cases of shoulder-joint excision for gunshot and other injuries and diseases. Of the 855 excisions executed for gunshot wounds, 267 died, or 31 per cent. Of 12 cases in which the operation was

done for injuries other than gunshot, 3 died, or 25 per cent. And in 11 excisions for diseases, 21 proved fatal, or 18 per cent. The result is a total mortality of 291, and a mean death-rate of 30 per cent. for the three classes. When considered in regard to the period of operation, it appears that when the excision was done for gunshot wounds and for injuries during the primary period, the death-rate was 25.45 per cent., while in the three classes of this author the mortality rate for the secondary operation was 32.66 per cent., and for the intermediary period 50 per cent.

Dr. Otis records 739 excisions of the shoulder-joint done on Union soldiers during the late American war, in which the terminations were ascertained with a death-rate of 35.7 per cent.

The above figures very forcibly point out the superiority of the primary and secondary periods for the execution of this operation, and the extreme danger of performing it in what is known as the *intermediary*, or the period of traumatic or inflammatory fever.

Gant has collected from the various civil hospitals in the United Kingdom 30 cases of excision of the shoulder-joint, exhibiting a death-rate of 1 in 4 cases, or 25 per cent.

When we compare the mortality attending excision at the scapulo-humeral articulation with that attending amputation at this joint, we find that the former is considerably greater. The mean mortality of 827 cases of amputation analyzed by Otis is 28.5 per cent., whilst the lowest mean recorded for excision by any of the authorities is 25 per cent. (except, for disease, by Culbertson, 18 per cent.), and the largest, that of Otis, 35 per cent.

The time required for recovery after decapitation of the humerus varies from three to four months, and, although the power to elevate the arm is rarely regained, almost every other motion can be performed with facility and strength.

Portions of the clavicle and scapula, along with the upper extremity of the humerus, were frequently removed during the War of the Rebellion. Forty-two cases of this nature are recorded. In three instances, along with the decapitation of the humerus, the acromion and coracoid process, the glenoid cavity, and the neck of the scapula were simultaneously removed. As the orbit traversed by the humerus includes the region bounded by these processes, these cases perhaps stand unparalleled as the most complete excisions of the scapulo-humeral articulations on record. Another point worthy of particular notice in connection with these 42 cases is the fact that the mortality—25 per cent.—was even less than that following excision of the head of the humerus alone.

For the removal of these processes the cutting pliers will be found most convenient.

Excision of the Elbow-Joint.—The conditions demanding excision of this articulation are as follows: *first*, compound luxation, with protrusion of the articulating extremity of one or more bones of the joint; *second*, shot wounds of the articulation, attended by extensive comminution; *third*, strumous or other disease followed by necrosis of the articulating extremities of the bones.

In cases of suppurating synovitis, even though the joint may be spoiled, and though there is no reasonable hope of ankylosis, the operation should not be practiced. Should, however, the health of the patient begin to fail under the suppuration, and hectic symptoms make their appearance, excision should not be withheld.

The operation has also been advised in cases of ankylosis of the elbow when in a vicious position. It will be better, however, under such circumstances, to make a subcutaneous division of the humerus above the condyles and establish an artificial joint.

OPERATION.—The patient having been etherized, the inner surface of the arm should be laid over a pillow rolled into a cylinder, and should be brought into a position slightly flexed.

Various incisions for exposing the joint have been proposed. Moreau, Butcher, and Syme employ two longitudinal incisions, one on either side of the joint, connected in the middle by a transverse cut, resembling the letter H. Jaeger and Liston are partial to a T-shaped incision. A simple longitudinal cut I find to answer every purpose. This plan of exposing the joint was first proposed by Park, who was the first to recommend excision of this articulation. It is also the plan adopted by Erichsen, Gross, Langenbeck, and Maunder. It has the advantage of not severing the triceps muscle from its connection with the ulna and the strong anconeus fascia, which blends with the posterior surface of the forearm. A longitudinal incision should, therefore, be made over the back of the joint, four inches in length, and penetrating to the tendon of the triceps muscle, the middle of which cut must be over the olecranon process of the ulna.

The triceps next should be divided to the same extent, down to the bone, and, carefully separating the external half with the anconeus muscle and the tricipital aponeurosis, the surgeon should have them held by a retractor over the external condyle of the humerus. This done, the internal half must next be lifted; in doing which the greatest care should be observed not to damage the ulnar nerve, lying in the groove between the internal condyle of the humerus and the olecranon process of the ulna and covered by a dense fibrous membrane. By opening this membrane on a director the nerve will be exposed, and can be dislodged from its bed and displaced with the inner half of the triceps over the internal condyle of the humerus; the nerve must then be held by a blunt hook or a retractor.

The surgeon, having now exposed the posterior surface of the humerus and the olecranon process of the ulna, with a pair of bone pliers cuts away the latter from its junction with the shaft of the bone. This accomplished, the lateral ligaments of the joint must be severed with a blunt-pointed bistoury, when the ends of the bones can (by flexing the arm, and by the use of the elevator and the fingers, peeling away the soft parts) be forced through the external wound.

A flexible spatula or shield is next to be passed between the soft parts, on the front of the joint, and the displaced bones, when the saw can be applied to the latter without endangering the vessels which are situated anteriorly.

The amount of bone to be removed must be determined by the extent of the disease or injury. When admissible, the excision should include only the articulating surface of the humerus, the olecranon as low as the coracoid process, and the head and neck of the radius above the tubercle. (Fig. 1086.) When executed within these limits, the insertion of the brachialis anticus muscle, at the root of the coracoid process, and that of the biceps flexor cubiti, behind the tubercle of the radius, will be preserved; and these will preserve to the limb the function of flexion. Complete excisions of the articulation are supposed to be attended with less danger to life, and less risk of ankylosis, than partial ones,—an opinion in which I do not concur when the operation is done for disease. The statistics drawn from military practice, however, are favorable to complete excisions, as the comminution is wide-spread in most cases.

Should the parts, during the operation, be obscured by hemorrhage, a tourniquet may be applied over the brachial artery. The Ésmarch bandage is followed by so much bleeding after its removal that I no longer employ it in these operations.

FIG. 1086.



Appearance of the bones after excision.

In separating the soft parts from the bones, the *subperiosteal* method may be adopted, if the surgeon is anxious to test the bone-regenerative capacity of the periosteum. But its value in this direction has, in my judgment, been very greatly exaggerated. Not a single dissection, so far as I know, has been made which verified the reproduction of the removed portions of bone, save that of Mr. Syme, which, however, exhibits only a very good attempt to establish a false joint.

DRESSING.—After securing any vessels which may bleed, and thoroughly cleansing the joint from all foreign matter with sublimated water, a drainage-tube should be introduced into the wound, its sides united by a few stitches of the interrupted catgut or silver suture, and the antiseptic dressing made with scrupulous care.

The forearm having been placed between pronation and supination, and at a right angle with the arm, is laid on an anterior angular splint or in a plaster trough, and the arm placed in a suspension apparatus. (Fig. 1087.) If, from

FIG. 1087.



Plaster splint made by a recurrent roller, and trapped at the elbow.

any cause, antiseptics is impossible, lint wet with cold water to which laudanum has been added, and which can be removed from time to time, may be applied as an imperfect substitute.

After two or three weeks the splint or plaster trough may be laid aside, and the arm placed upon an anterior angular splint having a movable joint. By this means the position of the limb can be gradually changed to an acute angle. Afterwards, at intervals of two days, it may be changed by flexion and extension, so as to initiate passive movements, and thereby both prevent ankylosis and secure a movable bond of union between the ends of the bones.

The value of excision of the elbow articulation may be approximately arrived at by considering the statistical data within our reach.

Dr. Hodges's collection of cases amounted to 119, of which number 15 died, or 12 per cent. Of Ashhurst's 19 cases, 6 died.

Otis records 627 excisions of the elbow, for gunshot wounds chiefly, though a few of them were for caries resulting from shot injury. Of these excisions the terminations were ascertained in 616 cases. Of the 616 there were 142 who died, making a mortality of 23.05 per cent. This proportion, when compared with the death-rate following amputation for the same class of injuries at this joint, shows a mortality of one-tenth of 1 per cent. in favor of the latter operation, and about the same as that following amputation of the arm, recorded by the same author as 26.7 per cent. Of 138 excisions of the elbow for the same injuries (gunshot), done by Confederate surgeons, 81 recovered, 19 died, and in 38 the termination was not known. Otis tabulates 588 excisions of this articulation, gleaned from various foreign sources, of

which number 321 recovered, 258 died, and in 9 the results were unknown, or a mortality of 43.8 per cent.

Dr. S. W. Gross has analyzed 499 cases of this excision for shot injuries, 400 of which recovered and 99 died,—a death-rate of 19.83.

The period of life at which this excision is performed exercises a great influence in determining its success. Of the cases collected by Dr. Gross, 79 were primary, with 9 deaths (or 11.39 per cent.), and 114 were secondary, with 23 deaths (20.13 per cent.); or 8.74 per cent. in favor of primary operations.

Shore has collected 82 cases of this resection. Of 14, in which the operation was performed for injuries, 12 recovered, and 2 results were doubtful. In 68, done for disease, 40 recovered and 20 died, making a death-rate of 29.41 per cent., liable to increase could the results of the other 8 cases be ascertained.

The cases of Erichsen and of Bickersteth together number 37, and record but 3 deaths. These operations were done for *caries* of the elbow-joint,—a condition which, should it have existed for some length of time, since it so changes all the articular components, would have rendered the joints excised exceedingly tolerant of cutting operations. Heyfelder and Boeckel have collected elbow-joint excisions embracing 145 cases, with 20 deaths and 125 recoveries; these give a death-rate of 13.10 per cent. Hodges has given 119 similar cases, with 15 deaths (or 12.60 per cent.) and 104 recoveries. These five investigators show, in the aggregate, 301 excisions of the elbow-joint, with 38 deaths and 263 recoveries. Among the 104 recoveries in Hodges's collection are included 15 amputations, rendered necessary by the failure of the excision, leaving 89 to be placed to the credit of exsection; and of this last number, 77 (or 86.51 per cent.) are represented as having had useful limbs.

Culbertson tabulates 1075 excisions of the elbow-joint, with 164 deaths, or a mortality of 15.25 per cent. Of this total number, 598 were excisions performed for gunshot wounds, 113 of which proved fatal, or 19 per cent.; 70 were done for injuries other than gunshot, with 10 deaths, or 15 per cent.; 377 were executed for disease, with 41 deaths, or 10.87 per cent.; 13 for deformity, with no deaths; and in 17 the result is unknown.

Gant's collection embraces 219 cases, with 197 recoveries and 22 deaths, or 10 per cent. Among the recoveries were 1 which required amputation, and 2 which were twice excised.

These data are sufficient to place excision of the elbow-joint among the established operations of surgery.

HISTORY.—Mr. Park, of Liverpool, first suggested the idea of excising the elbow-joint; and, although he never performed the operation, that he contemplated its execution is evident from his having, as a preliminary measure, cut out this articulation from the dead body. In 1758, Wainman, of Skipton, England, had a case of compound luxation of the elbow-joint in which the humerus was forced through the wound in the soft parts and some distance into the ground. Its lower extremity was sawn off with the olecranon fossa. In 1775 a partial excision of this joint was done by Justamond, of London, in which the olecranon process with two inches of the ulna was excised. The same year a surgeon of Gloucester, Mr. Tyre, cut away the lower end of the humerus in a case of compound luxation of the elbow-joint,—an operation similar to that which had been done seventeen years previously by Wainman. The operation was also performed in 1783, in removing the lower end of the humerus for *caries*.

The first complete excision, however, was successfully performed on the 29th of August, 1794, by the elder Moreau, at the Military Hospital of Bar-sur-Ornain. The patient was a soldier, who was suffering from *caries* of the bones of the elbow-joint, entailed by an old gunshot wound. In 1797 the younger Moreau performed a similar operation with success. Notwithstanding several of these excisions were performed by the Moreaus, the

operation appears to have attracted very little attention in France until 1819, when it was again brought before the profession by Roux.

In England, the first complete excision of the elbow-joint was done in 1818, by Stansfield, of Leeds; in Ireland, in 1823, by Crampton, of Dublin; and in the same year, in Germany, by Textor. In Scotland, Syme became a strong advocate for the operation, performing his first excision in 1828, and between this year and 1830 resecting sixteen elbow-joints. In 1831 and 1833 two complete excisions of the same articulation were done in Scotland,—the first by Kerr, of Aberdeen, and the second by Sterling, of Glasgow.

In the United States, the first excision of the elbow was performed by John C. Warren, of Boston, Massachusetts, October 16, 1834, and on the 16th of January, 1841, a second was done by Gurdon Buck, of New York. The first excision performed in this country for a shot wound of the elbow was done by Hoyt, of Hudson, Wisconsin, in 1847, on a soldier, at Jalapa, during the Mexican War.

The history of this important operation is like that of many others in surgery: the procedure is forcing its way to professional confidence only after many years, and chiefly through the courage of a few brave men who were determined to lead whether others would follow or not. It is sad to consider the sanguinary wars which were waged between 1794 and 1828, and the number of arms that were amputated which might have been saved had the method of excision received that attention to which it was entitled by the success attending the operations of the Moreaus.

Excision of the Radio-Carpal or Wrist Joint.—The object of excising this joint is to preserve the hand. The causes which render the operation necessary are disease of the articulating ends of the bones, and gunshot or other injury.

By excision of the wrist-joint I mean the removal of the articulating ends of the radius and ulna, together with the first row of carpal bones.

OPERATION.—In performing the operation, two things are to be observed: first, the preservation of the tendons, in front and on the back of the joint, intact; and, second, the removal not only of the bones concerned in forming the articulation (that is, the lower end of the radius and ulna and the first row of the carpus), but also of the entire carpus and the articulating ends of the metacarpus, if the disease or injury demands it. This operation is both a difficult and a tedious one.

A variety of incisions for exposing the joint have been practiced. That of the elder Moreau, who was the first to excise this articulation, was J-shaped, while that of Velpeau was quadrilateral. Others have employed an H-shaped incision, which must necessarily have been fatal to the future usefulness of the tendons.

The incision which I have employed (after etherizing the patient and applying a tourniquet to the arm) consists of two longitudinal cuts (I I), one on the radial and the other along the ulnar border of the wrist. The first should commence one inch and a half above the styloid process of the radius, and should terminate half an inch beyond the carpal extremity of the metacarpal bone of the thumb, passing between the extensors of that bone and of the first phalanx of the thumb. Care should be taken not to divide the radial artery, which lies in the hollow below the styloid process of the radius. The second incision is made on the ulnar side, beginning on a level with the prominence of the ulna, and ending half an inch below the metacarpal bone of the little finger.

The soft parts, including all the tendons, must next be dissected carefully from the back of the radius and the carpus.

The radial artery should now be displaced from the radio-carpal fossa, drawn downward by means of a retractor, and held out of the way; while with a long, narrow, *sharp-pointed* bistoury passed between the radius and ulna and the soft parts in front of the wrist, the surgeon shaves the latter

from the former, thus opening the wounds on either side of the joint into each other. As the knife reaches the carpus, it will become arrested on the ulnar side by the pisiform bone, the separation of which from its connection with the unciform bone must now be made. Thus the attachment of the tendon of the flexor carpi ulnaris is preserved.

The lateral ligaments being now divided, the radius and the ulna should be pushed through the wounds on the outer and inner side of the wrist, and their ends should be cut off on the same level.

After the removal of the extremities of these bones, the carpus can be brought into a position quite accessible to the knife.

The operator now, with a straight, *blunt-pointed* bistoury, divides the ligaments, uniting the two rows of the carpus on the dorsal surface. After this is done, with one blade of the cutting pliers pressed into the opened joints and the other blade applied in front, the upper can be severed from the lower row, and extracted, entire or piecemeal, by the bone forceps.

Should the disease have extended beyond the first row of carpal bones, it will be proper to excise the entire carpus, after the plan adopted by Mr. Lister. This surgeon advises, in all cases rendering the total excision of the joint necessary, that the entire carpus should be removed, together with the carpal extremities of the metacarpal bones,—a procedure which I am not prepared to accept until a larger experience has established its necessity. In two cases of wrist excision I did not adopt this plan, and in both I obtained an excellent result.

The method of Mr. Lister consists in making two longitudinal incisions along the radial and ulnar borders of the wrist. The first cut must commence a short distance above the level of the styloid process of the radius and over the middle of the back of the radius. At first it is carried towards the ulnar side of the metacarpo-phalangeal joint of the thumb, and parallel with the course of the extensor secundi internodii pollicis tendon; but on reaching the radial side of the metacarpal bone of the index finger it is prolonged downward, along the side of the latter, to a point nearly opposite the metacarpo-phalangeal articulation of the thumb. (Fig. 1088.)

The tendon of the extensor secundi internodii pollicis and the dorsal branch of the radial artery are next to be very carefully detached from the bone on the outer side of the incision, while on the inner side the tendons of the extensor carpi radialis longior and brevior are to be severed from their connection with the carpus.

This done, the next procedure is to divide with bone pliers the attachments of the trapezium to the surrounding pieces of the carpus, by which means the latter will be more readily removed.

The incision on the ulnar side of the joint is next made. This should extend from about two inches and a half above the styloid process of the ulna to the middle of the metacarpal bone of the little finger. The soft parts must now be carefully raised from the back of the wrist and the carpus, by keeping the edge of the knife turned towards the bones until the wounds on the two sides of the articulation communicate. While this is being effected, the tendon of the extensor carpi ulnaris will require to be divided close to its insertion.

The operator next proceeds to raise the structures in front of the radius and ulna, and also to sever the pisiform and the unciform process of the unciform bone,—the latter by means of the cutting pliers. The dissection

FIG. 1088.



Lines of excision.

should stop short of the deep palmar arch. After dividing the ligaments of the carpal bones, the latter must be removed by the bone forceps.

It remains to cut away next the articular ends of the radius and the ulna. This is readily done by turning first one and then the other out of the lateral wounds, and applying to them the saw. The ulna should be excised above its articulation with the radius; and the radius, when the disease or the injury will allow, should be excised sufficiently low not to disengage too much the tendons from its grooves. Under all circumstances, however, the

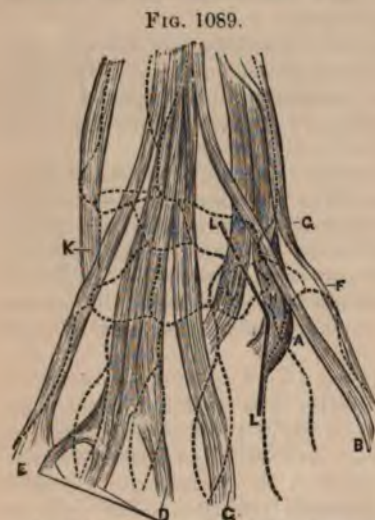
two bones should be removed on the same level, otherwise it will be difficult to prevent permanent adduction of the hand.

The carpal or cartilaginous ends of the metacarpal bones are now to be removed with the cutting pliers, turning them out of one or other of the lateral wounds, as may be found most convenient.

The trapezium, having been previously separated from the other bones of the carpus, is next to be dissected out, and so also the end of the metacarpal bone of the thumb, taking care not to injure either the flexor carpi radialis or the radial artery, which lies close to the tendon of this muscle.

Last, the articular surface of the pisiform bone is to be removed, and the hooked process of the unciform likewise. Fig. 1089 (from Lister) supplies a diagrammatic view of the structures involved in the operation of Mr. Lister.

DRESSING.—A drainage-tube, or a twist of oakum previously treated by carbolic acid, should now be passed across the wound from side to side, the edges of the incision stitched together, and the hand



A, radial artery; B, tendon of the extensor of the second phalanx of the thumb; C, extensor indicis; D, extensor digitorum communis; E, extensor minimi digiti; F, extensor of the first phalanx of the thumb; H and I, extensor carpi radialis longior and brevior; K, extensor carpi ulnaris; L L, line of incision on the radial side of the wrist and hand.

and forearm placed over a splint well padded. This should be provided with convex pieces of cork or pine wood fastened to the palmar part of the splint, over which the palm of the hand and the thumb, covered by a water or a carbolated dressing, are to rest, and to which they are to be bandaged by the turns of a roller. (Fig. 1090.)

During the subsequent treatment, passive motion of the fingers and thumb

FIG. 1090.



Splint applied after excision of the wrist.

and metacarpus must be kept up, in order to prevent any tendinous or bony adhesions, which might destroy the usefulness of the hand.

The complex nature of the wrist and carpus, together with their numerous blood-vessels, tendons, and bursal and synovial membranes, must necessarily render excision a difficult and embarrassing operation, which, in view of the deformed and helpless state in which recovery often leaves the hand, tends to excite doubts in the minds of many as to its propriety. With reference

to the first difficulty,—that of executing the operation,—patience, caution, and skill can surmount every obstacle. As to the second objection, it may be said that the preservation of the hand, even if its functions are badly discharged, is vastly to be preferred to its entire removal.

Another and a much more important matter to be considered in resolving the question is the risk to life as compared with other plans of treatment. Hodges tabulates 31 cases of wrist-joint excisions with known terminations. Of this number 6 died,—a death-rate of 19.35 per cent.; 8 required subsequent amputation; and 14 recovered. Dr. S. W. Gross has collected and analyzed 43 cases of this excision, performed on account of shot injuries, with 36 recoveries and 7 deaths,—or a death-rate of 16.28 per cent. The mortality, both in Hodges's and in Gross's collection, is considerably greater than that after amputation of the forearm, which is a trifle over 12 per cent. Mr. Lister has reported 15 cases of excision of the wrist articulation, with 3 deaths, or 20 per cent.

Otis, in his analysis of excisions for shot injury of this joint, has collected 96 operations, followed by 81 recoveries and 15 deaths, or a mortality of 15.62 per cent. But among the recoveries there were 9 amputations. Only 6, however, of the 96 cases were examples of total excision, 5 of whom recovered and 1 died,—a death-rate of 16.66 per cent. The condition of the hand after recovery is mentioned in 59 instances,—“51 had ankyloses at the wrists; 5 mobility with deformity; and 3 dangling joints.”

Gant has recorded from different sources 32 cases, with 26 recoveries and 6 deaths, or 1 in 5 $\frac{1}{4}$.

When it is considered that in many of these cases the operation consisted in removing one or more bones of the carpus, or the extremity of the radius or the ulna, it is evident that these statistics can only be made proximately available in determining the value of wrist excisions in the proper sense of that term.

In comparing the results of excisions of the wrist-joint with those of amputations at the same joint, and with amputations of the forearm, we find that of the former (that is, amputations through the radio-carpal articulation) there were 68 operations with 7 deaths, or a death-rate of 10.29; and that of amputation through the forearm there were reported 1747 operations, with a mortality of 13.9 per cent.,—a gain in favor of amputation over excision of 6.45 per cent.

If now we compare the mortality attending excisions and amputations done at the most favorable time, namely, the *primary* period, it will be found that the death-rate for the former was 10.29, while for the latter it was only 9.6 per cent.

Professor Culbertson has tabulated 182 cases of wrist-joint excisions, partial and complete. These include operations done for gunshot wounds, for injuries other than gunshot, and for disease. For the 70 cases embraced in the first class the mortality rate was 15.87 per cent.; for the second class, 16 in number, 50 per cent.; and for the third class, 92 in number, 13.66 per cent.; or for all classes together, 29.84 per cent. Twenty-four of the 182 cases are recorded as total or complete excisions. All the rest, as far as determined, were partial.

In estimating the comparative mortality attending the partial and the complete excisions in the different classes, the same author states that following the partial excisions for shot wounds there were no deaths, while in those which were total the death-rate was 20 per 100. For injuries other than shot wounds the mortality was 50 per cent. for partial excisions,—the only operations that were done in this class. And in those operations executed for disease the death-rate for partial excisions was 20 per 100, while for complete excisions it amounted to only 8 per 100.

Upon analyzing the data furnished by the different writers who have been quoted, it will be found that the results of excisions for the same class of injuries or diseases, so far as the comparison can be made, do not materially differ.

The statistics of wrist-joint excision furnished by the late American war are sufficiently large to aid us in determining approximately the value of this operation as a conservative measure in shot injuries. When it is contrasted with the treatment of this class of injuries by the expectant plan, by amputation through the radio-carpal articulation, and by amputation of the forearm, we obtain the following results:

Shot wounds treated by excision yielded a mortality of 15.6 per cent.; by expectancy, 7.6 per cent.; by amputation through the joint, 10.6 per cent.; and by amputation through the forearm, 9.6 per cent. This showing is decidedly against excision, though the numerical disparity between the cases treated by these different measures must not be overlooked.

In view, however, of the exceptional skill necessary for the proper execution of this operation, and the subsequent transportation of the patients from temporary to permanent hospitals, often over very considerable distances and attended with more or less personal exposure,—all conducing to inflammatory accidents,—to which may be added the disadvantages of a change of medical attendants, I have no hesitation in saying that excision of the wrist-joint for shot injuries must have a very limited application. On the other hand, in cases of disease where the alternative lies between excision and amputation, if the necessary skill can be commanded for its performance, and all the indispensable arrangements are at hand for conducting the details of the subsequent treatment, and, not the least important, if the patient is not past the period of adult life, is free from any serious organic disease, and is not broken down in health, excision should be accepted without hesitation, as in the event of failure the chances of recovery by amputation are not lessened.

HISTORY.—In a case published in 1756, Bagieu, in a shot wound of the wrist, removed the carpal extremities of both the radius and the ulna,—the first recorded example of a partial excision of this articulation.

Cooper, of Bungay, in 1758, in a case of compound luxation of the wrist, cut away the lower end of the radius which projected through the external wound. The patient was young, and recovered without having either the mobility or the strength of the articulation materially affected.

About the year 1772, Dr. Ored, of Chester, excised three inches of the lower end of the ulna in a young man for disease. Some doubt has been expressed whether this was an excision, as the phraseology used seems to imply that the operation was done in the continuity and not in the contiguity of the bone. Birnbaum, a French military surgeon, in 1759 removed by excision a number of pieces of bone from the wrist of a soldier.

Moreau the younger in 1794 excised the radio-carpal articulation of a seamstress, with a good result. About 1823, Verbeeck removed the lower end of the radius in a lad fourteen years of age, with a recovery. Roux in 1830 cut away the articular extremity of both the radius and the ulna; and in 1834 Jaeger excised the lower end of the ulna for a shot wound. The operation in the latter case failed, after which the forearm was amputated, the patient not recovering.

After the last-named date these operations became more common, being executed in France by Roux, Maisonneuve, and others; in England by Ferguson, Erichsen, Stanly, Butcher, and Hancock; and in Germany by Langenbeck, Baucken, Kuster, and other surgeons.

Excisions of Portions of Bones of the Hand.—The excisions practiced on the bones of the hand are carpal, metacarpal, and phalangeal. The importance of the hand as a prehensile, tactile, and defensive mechanism is so great that in no other part of the body does there exist so much necessity for conservative surgery. In general it may be said that in all operations upon this member the utmost care should be observed to sacrifice no portion which it is possible to preserve. When the alternative is presented of sacrificing either symmetry or function, the former must yield to the latter, though

all operations should as far as possible proceed upon the principle of preserving both.

At the same time it does not answer to adhere too rigorously to the maxims of preservation. For example, when the proximal or intermediary phalanges are disorganized by disease or by injury, it would be a useless procedure to attempt their excision, as the remaining ungual phalanx and the mass of soft parts would be worse than functionless,—rather an incumbrance or obstruction to the use of the remaining parts of the member. Amputation under these circumstances is to be preferred.

When, however, the distal or ungual phalanx has been destroyed by accident, or by whitlow or other disease, its excision should be practiced, as the remaining soft parts, having the second phalanx to rest against, will still serve to prolong the digit. In the flexion and extension of the fingers consists their usefulness; and therefore as far as possible these functions must be preserved,—especially the flexion and extension of the *proximal* phalanx, which if saved will in a good degree compensate for the loss of the same movements in the second and last phalanges, as the last two must follow the movements of the first.

OPERATION.—If the cause demanding an operation is confined to the metacarpal extremity of a phalanx, its excision will be proper. This may be done by a longitudinal dorsal incision commencing over the lower end of the corresponding metacarpal bone, and prolonged to the extent of an inch over the phalanx and made parallel with the edge of the extensor tendon. This last should be carefully raised without being cut, and pressed to one side out of the way of injury.

The disarticulation being effected by the division of the connecting ligaments, chiefly the lateral, the diseased extremity can be readily clipped away by the bone pliers.

The *after-dressing* consists in thoroughly washing the wound with the sublimate solution, applying an antiseptic dressing, and placing the hand on a palmar splint with a conical padding, so as to allow the diseased as well as the other fingers to be preserved in a slightly flexed position. The hand and forearm should be bound to the splint loosely with a roller.

When the *ungual phalanx* requires resection, it may be done either by a longitudinal incision made over its palmar surface or by one carried transversely across the end of the finger. In the first the soft parts should be dissected away from the bone laterally; in the second they should be separated from before backward, until the disarticulation can be effected. In either event the knife should be kept close upon the bone.

After the denudation of the bone the disjunction can be facilitated by seizing the piece with a pair of bone forceps and twisting it in different directions, while the ligaments which unite it to the adjoining phalanx are divided by the knife. The dressing afterwards required is a palmar splint, as in the operation previously described.

The thumb.—The functional importance of the thumb to the usefulness of the other part of the hand is so great that its loss is a grave calamity, and one which no prosthetic contrivance can remedy.

No part, therefore, of this portion of the member should be unnecessarily destroyed. Even if it should be saved at the expense of all motion, remaining permanently stiff and constrained, its value cannot be over-estimated. Excision of its metacarpo-phalangeal joint, or of a part, or even the whole, of its metacarpal bone, may be done without destroying its usefulness.

The *metacarpal bones* not unfrequently require excision in consequence of disease or injury.

The excision of that of the *thumb* requires a longitudinal incision made exactly in the line of junction between the dorsal and palmar skin. The muscular cushion on the inner surface, and the extensor tendons on the outer, must be raised by keeping the knife directly in contact with the bone, thus preventing hemorrhage as well as preserving the structure. After the bone

has been isolated, it must be disarticulated from its proximal phalanx; or, if the condition of the metacarpal bone will allow, it may be severed by the cutting pliers a short distance back. After this is done it must be drawn out of the external wound and dissected from all its surrounding connections back to the trapezium, from which it can be detached by a few touches of the knife.

The remaining portion of the thumb, having lost much of its support, should be bound to a splint of binders' board moulded neatly to its palmar surface, and so retained until consolidation has taken place.

In excising the other metacarpal bones the incision should be longitudinal, and made over the dorsal aspect of the bone in such a manner as to avoid the extensor tendons.

By keeping the edge of the knife against the piece to be removed, it is not difficult to separate it from the surrounding parts. Then it can be removed by disarticulating it first from the metacarpus, or by seizing it near to this joint with the cutting pliers, when the disease will allow, and, after drawing it out, dissecting it towards its phalangeal articulation. From this it must be separated; or, if not disorganized to this extent, it must be cut off in the manner directed for removing its carpal extremity.

Whenever it is possible, the periosteum should be preserved in these operations, as a certain amount of new bone will be formed, which, though it may be a mere caricature of the original piece, will aid very much in establishing a line of resisting tissue for the support of the finger.

In caries or necrosis this membrane is often found considerably thickened, and its separation is by no means difficult.

Metacarpus.—Excisions of individual pieces of the metacarpus may be required in compound luxation or in disease. And, as in similar operations upon the metacarpus, the bone or bones must be exposed on the dorsal surface of the hand, the operator exercising the same care with reference to the superincumbent tendons as in the other operations.

After exposure the piece may be dealt with either by the gouge or by the knife and forceps. In my own experience these operations on the carpus have never proved satisfactory.

Excision of the Sternum.—Partial operations of this nature have been done for gunshot injury, for abscess in the anterior mediastinum, for caries, and for the extraction of foreign bodies. Heyfelder has collected 17 cases of partial excision of this bone, with a single death. I have removed, from a patient in the Philadelphia Hospital, a portion of the gladiolus, for evacuating, as I supposed, an abscess of the anterior mediastinum. Though no pus was discovered, the sternum was found in a state of caries. No evil effects followed the operation. In one instance, Linoli, in consequence of great distress and vomiting (caused by the contact of the inverted ensiform cartilage with the surface of the stomach when the latter was distended), excised the appendage with entire relief of the symptoms. Assistant Surgeon McGill, during the late American war, in the case of a sergeant wounded at Petersburg, Virginia, by a conoidal ball, after extracting the broken fragments of the sternum, observed the pulsations of the heart,—the latter organ being extensively exposed.

The sternum is rarely the subject of necrosis, though it is frequently attacked by caries, especially that of a syphilitic nature. As its formation is almost wholly spongy, the tendency of the disease is to extend throughout the structure of the bone. No operation, therefore, should be undertaken for disease unless the indications for its performance are very clearly established.

The statistical details of these excisions are far from being satisfactory,—indeed, are open to very just criticism. When the sternum is comminuted, from shot or injury, the extraction of loose pieces will always be proper. When no constitutional vice of a syphilitic or tubercular nature is present

in the system, fractures of this bone usually do well. The records of the late American war furnish 51 cases of gunshot fracture of the sternum, with 18 deaths, or a mortality of 35.3 per cent., the fatality being largely due to concomitant injuries sustained by the contents of the chest.

When a formal excision of a part of the sternum is demanded, the bone may be exposed by a longitudinal, crucial, or semilunar incision, and the affected part cut out with the trephine, the gouge, or a Hey's saw.

Excision of the Ribs and their Cartilages.—Excision of the ribs is an operation rarely demanded. The causes for which such interference has been deemed necessary are caries, necrosis, carcinoma, enchondroma, and gunshot injury. Necrosis as compared with caries of the ribs is exceedingly rare. I have met with several cases of caries of the ribs or of their cartilages, occurring as a sequel of typhoid fever, and in one instance resected portions of the cartilages of the seventh and eighth. In other cases, where the patients were treated on the expectant plan, recovery, though slow, eventually took place: so that, unless there be conclusive evidence of a necrosed fragment, giving rise to inflammatory irritation of the pleura beneath, or the disorganization of a considerable portion of a rib, I believe it is safer to leave the separation and expulsion of the affected part to natural processes. When, however, a marked growth on the side of the chest is developed, and the ribs become involved in the disease, excision will be proper, provided the general system does not exhibit marks of a malignant dyscrasia. In gunshot wounds attended by comminution of a rib, the loose fragments should be extracted.

OPERATION.—When the operation is performed for caries, an incision should be made directly over the diseased rib and parallel with its course. After dividing the tissues down to the bone, the periosteum should be incised, and, by means of an elevator, carefully separated from its connection with the rib—first on its external and afterwards on its inner surface.

In both caries and necrosis this is not difficult to accomplish, as the membrane is usually greatly thickened by inflammatory agencies. By keeping in close contact with the rib, the pleura and the intercostal vessels can be detached without risk to either. It is otherwise, however, when the operation is undertaken for tumors implicating these bones; here the danger to the pleura is very great, and its separation without lesion requires the greatest patience and care.

The incisions in such cases should be elliptical, or of any other shape that will give the freest exposure of the parts.

When the rib is once isolated, it may be divided in different ways. A chain-saw may be carried beneath it, and made to cut from within outward; or, a piece of leather or wood having been passed between the bone and the pleura to protect the parts, the division may be effected by a metacarpal saw; or, finally, it may be done by the cutting pliers.

As soon as the section has been made, the rib should be drawn forward, when it can more satisfactorily be peeled off from its subjacent connections, by means of the elevator, to the extent necessary. It can then be again severed by the pliers or saw and the segment removed.

The *dressing* consists (after any vessels requiring ligature have been tied) in bringing the edges of the wound together by the interrupted suture, and giving additional support by a compress, held in place either by adhesive strips or by a broad bandage surrounding the chest.

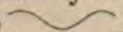

HISTORY.—Excision of the ribs is one of the most ancient operations in surgery. At least we are led to this conclusion by the frequent allusions made to the subject in the works of Celsus, Galen, Severinus, and others. Velpeau records an operation of this nature by Suif, in which the surgeon, after resecting two ribs and leaving an opening into which the hand could be thrust, removed a large portion of the right lung. Portions of the cartilages were resected by Moreau, Jaeger, and Kuchler. Richerand excised portions of

four ribs, and with them a considerable amount of the thickened pleura, exposing to the eye the pulsations of the heart.* Dr. W. A. McDowell, of Virginia, receives the credit of having been the first in this country to remove extensive portions of the ribs.† This surgeon excised the greater portion of the sixth and seventh ribs on account of necrosis. Dr. M. Antony, of Georgia, in one instance excised the fifth and sixth ribs for caries, and at the same time removed a large portion of the right lung.‡ Warren, of Boston, in 1836, and again in 1837, executed an extensive operation on the ribs, in the first instance for the removal of an enchondroma, and in the second for an osteosarcoma growing from the side of the thorax.§ Three inches of the seventh and two inches of the sixth rib were excised in the first case along with the tumor; and in the last a part of the ninth rib, with its cartilage. Both patients recovered.

Dixon cut away the tenth costal cartilage, which had, by an accident, become separated from its rib, and, by irritating a contiguous nerve, occasioned a severe neuralgia. The patient recovered from the operation, and also from the pain.

Roux excised four inches of the fifth rib for necrosis, at the same time evacuating a considerable amount of pus which was confined between the bone and the pleura. This patient died from pleuritis.|| George McClellan, in 1842, in a patient suffering from spina ventosa, resected the sixth and seventh ribs almost from the cartilages to their vertebral extremities.¶ Death ensued nine weeks after the operation from what was regarded as bilious remittent fever. The same surgeon had previously, on several occasions, excised portions of the ribs for morbid growths and for caries. Professor Gibson also executed an extensive resection of portions of two ribs for a malignant disease. Professor Gross, in 1857, successfully removed the central portions of the fifth and sixth ribs on account of scrofulous disease.** The pulsations of the heart were exposed at the bottom of the wound. Heyfelder studied the history of 37 cases of excision of parts of the ribs, all of which recovered except 8.

Excision of the Hip-Joint.—Excisions of the coxo-femoral articulation may be required in consequence of shot or other injury, and for caries or necrosis following hip-joint disease. Such operations, however, rarely contemplate more than the decapitation of the femur, or the removal, at most, of the head and neck of the bone, and of the trochanter major. In cases where the acetabulum is found necrosed, it is, nevertheless, highly proper that the diseased portions should be cut away with the gouge, scraper, and forceps.

OPERATION.—Incisions of various forms have been practiced for exposing the articulation by different operators. Thus, we have the longitudinal, |; the curvilinear, ; the crucial, +; the semilunar, ; the V-shaped; and the T-shaped. The first or longitudinal incision is that proposed by White,—who originally suggested the operation. This, or one somewhat resembling the italic *f*, which I prefer, answers every purpose. (Fig. 1091.)

The patient, having been put under the influence of an anæsthetic, should be placed on the sound side. The surgeon now feels for the great trochanter, and, commencing one inch and a half above its summit, makes a curvilinear incision down along the posterior border of the process, terminating about two inches below its base, and making a wound from five to six inches in length.

The knife should now divide all the tissues down to the bone, including the periosteum, and to the extent of the first incision. At this stage of the

* Medical Repertory, New York, 1818, vol. iv. p. 401.

† American Medical Recorder, 1827, vol. xiii.

‡ Philadelphia Journal of Medical and Physical Sciences, vol. vi. p. 108.

§ Boston Medical and Surgical Journal, 1837, vol. xvi. p. 201.

|| Chelius's Surgery, vol. iii. p. 767.

¶ McClellan's Surgery, p. 352.

** Gross's Surgery, vol. ii. p. 1080, 5th edit.

operation it is advised by Sayre to cut through the periosteum at right angles with and about the middle of the first wound, and then, by means of an elevator, carefully to detach this membrane from its connection with the bone, together with its tendinous attachments. When the periosteum is found thickened, this is not a difficult task; but if not thickened, its separation in any degree of entirety is scarcely feasible, and need not be attempted.

The sides of the wound being held apart by means of retractors, the tendons of the external rotator muscles are to be divided with a blunt-pointed bistoury; this must be done at their insertion in the trochanteric fossa.

With a finger introduced into the wound, any remaining shreds of tissue adhering to the bone should now be separated, and the head of the femur should be located by the touch (the certainty of which may be established by rotating the limb at the same time, when the head of the femur may be felt under the digit).

The next step consists in dividing the capsular ligament, which should be done on its anterior and lower part with the probe-pointed knife, and while the thigh is carried a little backward in order to render this ligament tense.

This accomplished, the limb must be adducted,—that is, carried across its fellow,—when the head of the bone will start out of its socket and appear in the external wound. The ligamentum teres may then be conveniently severed.

When the neck of the femur is in a state of caries, some care must be exercised in forcing the bone outward, as if too strong adduction is made it may readily, on account of its brittleness, be broken.

Two plans are pursued in dividing and extracting the articular end of the bone. In one the section is made by a chain-saw, passed beneath the femur and without displacing the latter, after which the diseased piece is seized with a pair of forceps, drawn forward into the wound, and its acetabular connections severed by touches with the blunt-pointed knife. In the other plan, the head and neck of the bone, after being freed from the restraint of the capsular and round ligaments, are, by abducting the limb, thrust through the external incision; and, after interposing between them and the bone and the soft parts a wooden or other spatula, they are sawed through from without inward. (Fig. 1092.)

The amount of bone to be removed must be determined by the extent of the disease or injury. Under any circumstances the whole of the trochanter major should be excised, leaving the trochanter minor intact. (Fig. 1093.)

If any part of the great trochanter is allowed to remain, it will prove a source of mischief, not only by projecting into the wound, but also by obstructing the free escape of the discharges.

By leaving the trochanter minor untouched, the insertions of the psoas magnus and iliacus internus muscles remain undisturbed.

FIG. 1091.



Line of incision.

FIG. 1092.



Head and neck of the femur displaced,—with the spatula beneath, preparatory to applying the saw.

After decapitation of the femur the finger should be passed through the wound into the acetabulum. If this cavity is involved in the disease, the

FIG. 1093.



Section of the upper end of the femur on a level with the base of the great trochanter.

gouge, scraper, and bone forceps will usually serve to remove the diseased portions. The entire floor of the acetabulum may be excised without exposing the cavity of the pelvis, as the internal periosteum and the obturator fascia serve to establish a secure barrier against intra-pelvic infiltration.

The excision having been accomplished, the bleeding arrested, and all foreign matter removed, a seton of oakum, or a rubber drainage-tube, must be carried down to the bottom of the wound. The sides of the wound are now to be supported by adhesive strips, but not brought together.

DRESSING.—If the operator has been fortunate enough to preserve the periosteum, it should be lightly stuffed with a long strip of iodoform gauze, in order to preserve its form and to favor an orderly reproduction of new bone.

The wound being now douched with the sublimate lotion, a large drainage-tube introduced, the edges of the incision brought together by a few interrupted sutures, and the usual antiseptic dressing applied, the limb should

be placed in the extended position, a little abducted, in order to prevent the upper end of the bone from entering the wound, and extension should be made by means of a weight suspended from the leg and thigh with adhesive plasters. Lateral pressure can be supplied by means of sand-bags placed along the sides of the limb.

FIG. 1094.



Wire breeches, or cuirass.

When the excision has been performed for a destructive caries following coxalgia, the *wire breeches* or *cuirass* (Fig. 1094), employed by Professor Sayre, constitutes an excellent dressing. This apparatus is constructed of wire, and has very much the shape of the human figure. After the apparatus has been well padded, the patient is placed in it. The foot of the sound limb is first secured to the foot-piece, which has been previously well padded both on its plantar and dorsal surfaces. A roller is now passed around the foot and foot-piece and continued up to the knee. Over the knee are placed some cotton and a splint of pasteboard, or several layers of stout paper, when the bandage is continued to the pelvis, and completed by several spicas of the groin.

Along the sides of the affected limb are placed adhesive plasters extending as high as the lower end of the wound, and running some distance below the foot. These plasters must be secured by a smoothly-applied roller, and, after padding the foot, their free ends are to be carried about the movable foot-piece, when, by turning a screw attached to the latter, the requisite degree of extension is made.

After the limb is brought into the desired position, a roller is carried from the foot to the groin, securing it to the cuirass, and, as on the sound side, ending by a spica including the thigh and the pelvis. The dressing to absorb the discharges from the wound can be readily applied through the large oval fenestra in the wire over the hip.

When the subject of the excision is over ten years of age, the dressing

ordinarily used for fracture of the thigh will answer every purpose, with the addition of a long outside splint, bracketed at the hip, or, what will serve the same object, a long sand-bag for the outside of the limb and body, and a short one for the inner aspect of the thigh and leg.

The conditions demanding resection of the hip-joint on account of disease have been already discussed under the head of coxalgia, to which the reader is referred.

The results of these excisions in military practice have been very carefully analyzed by Dr. Otis. Previous to 1861 there had been only 12 cases of this operation for shot wounds, all of which save one proved fatal, and during and after the War of the Rebellion 73 excisions of the hip were executed; making a total of 85 cases. Of this number 39 were primary, 33 intermediary, and 13 secondary operations.

Of the 39 primary, 36 died and 3 recovered,—a death-rate of 92.30 per cent.; of the 33 intermediary, 30 died and 3 recovered,—a death-rate of 90.9 per cent.; and of the 13 secondary, 11 died and 2 recovered; in all there were 77 deaths and 8 recoveries, or an average mortality of about 90.6 per cent. This result presents a gloomy and, at first sight, a very discouraging exhibit for excision of the hip-joint for shot injury; but, to see the subject in a just light, these figures must be compared with the results following the alternatives of this operation, namely, *amputation* at the hip-joint and the treatment by *expectancy*.

Dr. Otis has tabulated 183 amputations at the hip-joint, of which 79 were primary, 76 intermediary, 20 secondary, and 8 re-amputations. Of the 79 primary, 75 died, 1 recovered, and 3 were undecided,—a mortality of 94.93 per cent.; of the 76 intermediary, 70 died and 6 recovered,—a death-rate of 92.10 per cent.; of the 20 secondary, 13 died and 7 recovered,—a mortality of 65 per cent.; and of the 8 re-amputations, 4 died and 4 recovered,—a mortality of 50 per cent.; giving for the entire 183 operations 162 deaths, 18 recoveries, and 3 doubtful results, or a death-rate of nearly 90 per cent.

In 122 cases treated on the *expectant plan*, or by temporization, only 8 cases of recovery are recorded, leaving a mortality of 93.4 per cent.

We have, accordingly, a mortality of 90.6 per cent. for coxo-femoral excision; nearly 90 per cent. for amputation; and 93.4 per cent. for expectancy,—an exhibit slightly in favor of amputation.

Mr. Holmes tabulates his own 19 cases of excision of the hip for disease in children: 6 died from the direct effects of the operation; 1 died after the operation from previous effects of the disease; 1 died of independent disease; 2 recovered from the disease, but died a long time afterwards; 2 were little, if at all, benefited; 1 (twice excised) was doubtful; 3 had useful limbs, but with sinuses; and 3 recovered completely.

Of Dr. Hodges's 111 cases, 50 recovered, or 45 per cent. Gay gives 4 cases, with 3 recoveries and 1 death.* Ashhurst refers to 400 cases, in which the mortality was about 50 per cent. Of M. Good's 112 reported coxo-femoral resections, 52 were attended with success, and 60 were fatal,—a mortality of 53.57 per cent.† Of Dr. Sayre's 59 cases of exsection of the hip-joint for coxalgia, as tabulated by himself, 39 recovered permanently; 8 who had recovered from the operation died of disease entirely foreign to the operation; 4 died of acute intercurrent disease, and 8 from the exhausting effects of hip disease.

The fallacy, however, of attempting any absolute deductions from the military statistics which have formed the basis of the preceding conclusions has not escaped the attention of the critical mind of the surgical historian of the war, who intimates that, in all probability, all the successful cases of coxo-femoral amputations have been recorded, while, most likely, a number of the fatal cases have not been published; and, again, that secondary coxo-femoral amputations and re-amputations, where the primary injury was received low

* *Lancet*, September 15 and 22, 1872.

† *Gazette des Hôpitaux*.

down in the thigh, cannot fairly be compared with excision or temporization in cases where the original lesion was in the hip-joint. At the same time, in order that the operation by amputation should not be unfairly dealt with, he admits that the *worst* cases were subjected to this procedure. Again, the excisions are to be credited with many cases in which, in consequence of other lesions independent of those implicating the hip-joint, the results must necessarily have proved fatal.

No operation in surgery more imperatively demands, as a condition of success, immobility of parts than that of excision of an articulation. In a very large portion of the cases reported this was impossible, as the patients were transported after the operation over considerable distances; and even when in a permanent hospital they lacked the systematic application of the most effectual appliances for enforcing rest.

The statistics of the *expectant plan*, showing a mortality of 93.4 per cent., are sufficient on their face to give them no standing in court, and are exceedingly vulnerable to criticism in another point of view,—that of diagnosis. Except where the fact has been established by a digital exploration, it is very difficult to pronounce with certainty as to the existence of articular lesion. And there is abundant evidence to show that in some of the cases reported as recoveries after articular lesions no such injuries existed.

Culbertson has collected from various sources 121 cases of excision for shot injury at the hip-joint, with 106 deaths (or a death-rate of 87.6 per cent.), 13 recoveries, and 2 doubtful,—a result varying but little from that deduced from the compilations of Otis.

The question, then, as to the treatment of shot wounds of the hip-joint is really narrowed down to a choice between excision and amputation.

It is impossible to conceive that the skillful decapitation of the femur, if followed by immobility of the parts and free drainage, can prove so hazardous to life as the dismembering of the entire member from the trunk. In general it may be said that primary excision of the upper extremity of the femur will be indicated in all cases of shot injury of the articular extremity of the bone in which no other serious complication exists,—a statement which would remand to the domain of amputation all cases in which, in addition to a coxo-femoral fracture, there is a wound of the femoral blood-vessels, or a great destruction of the soft parts at the upper part of the thigh, or a multiple fracture of the thigh, or a comminution or splintering of the femur for several inches below the trochanter.

Three other conditions may also be stated as demanding amputation, even when the joint is not implicated:

First. When the femoral blood-vessels have been severed,—in which case the limb, if allowed to remain, must fall into a state of mortification.

Second. When the extremity is carried away by a cannon-shot, or when the femur is broken and the soft parts are torn away from the thigh so near to the pelvis that room is not left sufficient to obtain a flap without an excision of the bone.

Third. Amputation will also be demanded in the event of osteo-myelitis extending to the neck of the bone.

HISTORY OF HIP-JOINT EXCISIONS.—Excision of the head of the femur was suggested as early as 1769, by Charles White, of Manchester; the feasibility of which he had previously demonstrated upon the cadaver. It was not, however, until 1822 that it was performed on the living subject, when Mr. Anthony White, Surgeon to the Westminster Hospital, London, successfully excised the head and neck of the femur for deformity following coxalgia in a boy who had suffered several years from that disease. In 1828, Mr. Hewson, of Dublin, made the next formal excision for caries of the head and neck of the femur; and his operation was followed by those of Textor in Germany, who resected the hip-joint four times for a similar state of the articulation. In England, Sir Benjamin Brodie, in 1836, excised the head of the femur for disease. The acceptance of the operation by British surgeons as an estab-

lished surgical procedure was to be attributed in a large measure to the influence of Sir William Fergusson, who very early gave to the operation the weight of his great name and influence.

Dr. Culbertson has tabulated 177 cases of complete excision of the hip-joint for disease. Of these, 90 recovered, 77 died, and in 10 the terminations were unknown. The mortality from these operations was, therefore, at least 44 per cent.

In 121 cases of hip-joint excision for gunshot wounds collected by this author, 106 (or 88.4 per cent.) died, 13 recovered, and 2 results were doubtful.

In France, where the Moreaus had labored so hard to popularize resection, but little attention was given to the subject. Both Roux and Gerdy advocated the operation under certain limitations,—the former having, in 1847, divided the upper end of the bone for ankylosis. But Boyer, whose authority was wellnigh despotic, was adverse to the procedure.

In 1849 the first operation of coxo-femoral excision for disease in the United States was executed by Dr. Wilcox, of Easton, Pennsylvania. This was succeeded, in 1850, by that of Professor Buchanan, of Glasgow, Scotland. Two years after, Professor Bigelow, of Boston, performed a similar operation upon a lad for caries. Excision has been brought to the favorable notice of the American profession largely through the labors of Professor Sayre, who, in 1844, executed successfully the removal of the upper extremity of the femur in a case of coxalgia. Since that period he has repeated the operation 59 times. Similar excisions were also done by Markoe, Church, Mott, Krakowizer, Holston, and Kinloch,—the number nearly every year increasing, so that in 1861 Hodges's collection embraced 44 operations of this nature. In Philadelphia, this operation has been practiced by almost every surgeon of prominence, and particularly by Dr. John Ashhurst and Dr. H. Lenox Hodge.

The first excision of the head of the femur for gunshot injury, and chronologically the third, was done by Oppenheim, of Hamburg, Germany, on a soldier wounded in a Russo-Turkish battle. After undergoing the operation the patient was moved some distance to a hospital, and lived seventeen days, but died apparently from pyæmia or some blood-poisoning, contracted, it was supposed, from a patient who died in the same ward of the plague. In 1832 Sentin excised, unsuccessfully, the head, neck, and some inches of the shaft of the femur of a private shot at the siege of Antwerp. Dr. Gross, in 1850, removed the head and neck of the thigh-bone for caries following gunshot injury. The patient died. A post-mortem examination revealed extensive disease of the kidneys and liver, which, together with two attacks of hemorrhage, was chiefly concerned in occasioning a fatal termination of the case. The next operation was in 1854, by Prof. Baum, also with a fatal result. The year 1855 was remarkable for the performance of six excisions of the hip-joint,—all done during the Crimean War. The first of these was by Dr. Macleod, of Glasgow, who removed the head, neck, and great trochanter of the femur from a young man shot in an attack on a Russian fortress. This excision was followed by those of Mr. Blenkins, Staff-Surgeon Crerar, Mr. O'Leary, George Hyde, and Dr. Coombe. All of these patients died except Mr. O'Leary's, who recovered with a useful limb.

The first American operation of the kind was performed by Dr. Sterling, of Cleveland, Ohio, in 1864, with an excellent recovery.

Excision of the Knee-Joint.—With the exception of the elbow-joint, the knee-joint has been more frequently excised than any other articulation of the skeleton. The operation is one of great severity as well as danger, and should not be undertaken except under a conspiracy of the most favoring circumstances. The causes rendering a resort to the procedure necessary are strumous disease of the knee-joint, ankylosis, and gunshot and other injuries.

The circumstances which make this excision so grave are, first, the mag-

nitude of the joint, and necessarily the exposure of a large surface of cancellated tissue,—a condition favoring the introduction of septic matter into the blood; and, secondly, the peculiar form of the resulting wound, which is large and sacculated, and unfavorable to free drainage.

OPERATION.—Park was favorable to a crucial incision for the exposure of the joint, the arms of the cross intersecting at the upper margin of the patella, while Moreau preferred an H-shaped incision. The easiest and most expeditious plan, however, of reaching the articulation—one which not only furnishes ample space for attacking the bones, but also admits of an accurate adjustment of the sides of the wound—is a *semilunar* or *horse-shoe-shaped* incision, first practiced by Mackenzie.

The patient being etherized and brought to the end of the table, or to the edge of the bed, with the sound limb resting on a chair or stool, an assistant supports the leg of the affected side in an extended position. The surgeon now makes a semilunar incision, with its convexity downward, across the limb, commencing behind the tuberosity of the condyle of the femur on one side, passing down the leg to a point opposite to the tubercle of the tibia, then across the latter prominence to the opposite side of the leg, terminating behind the tuberosity of the other condyle of the femur. The extremities of the incision being well back towards the ham will favor the drainage of the wound.

In making the cut on the inner side of the joint, care must be taken not to wound the internal saphena vein, the position of which, if not visible, can easily be made so by applying pressure over the vessel just above the knee with the fingers, when the vein will become sufficiently distended to be recognized.

The flap should next be raised, cutting off the *tendo patellæ* as the dissection is carried upward, and thereby uncovering the front of the joint. (Fig. 1095.)

The leg must now be flexed, while the lateral and crucial ligaments are being divided. In severing the latter, some caution must be exercised that the point of the knife does not get out of sight of the operator and puncture the tissues on the posterior aspect of the articulation; should this occur, the popliteal vessels would probably be damaged.

At this stage of the operation the patella can be most conveniently removed. For this purpose the knife can be passed between the bone and its capsule.

The division, next, of whatever soft parts may be in contact with the femur and the tibia will admit of the bones being protruded through the external wound. Their articular extremities can then be removed by Butcher's saw. The saw should be passed first beneath the femur and then beneath the tibia (if both are involved in the injury or disease), and the cutting done from behind forward; or, if this instrument is not at hand, interposing a wooden spatula behind the bones, they may be sawed off with an ordinary amputating saw from before backward. (Fig. 1096.)

In the ablation of the bones there are two points which demand attention,—first, the *direction* of the section, and, second, the *amount* to be removed. With regard to the former, the obliquity of the condyles of the femur must be noted, and the incision made in a line exactly parallel with the articular surfaces of both condyles. If this direction is disregarded, and the section made directly transverse to the longitudinal axis of the bone, when the parts are adjusted the knee will have an outward curve. In cutting off the end of the tibia, the division should be made so as to leave a surface *slightly oblique* from before backward.

The *amount* of bone which it is proper to remove, when the excision is

FIG. 1095.



Anterior semilunar flap cut and turned up in front of the thigh.

executed on account of injury, must of course be limited only by the extent of osseous involvement. But when the case is one of disease, and in a young subject, before the consolidation of the epiphysis and the diaphysis has been completed, the morbid changes of the bones will generally be confined to the epiphysis alone, and the section, therefore, should be made below the cartilaginous conjunction of this process with the diaphysis. The necessity for observing this rule is, that the operation shall not interfere with the subsequent growth in the length of the limb. Accordingly, in dividing the femur, the saw must not be allowed to go above its trochlear surface. In dealing with the tibia the same course is to be pursued, — removing its extremity as in cutting away the end of the femur. The saw should not trench, if it is possible to prevent it, on the cartilaginous conjunction of the epiphysis, though the latter plays a less important part in the subsequent growth of the limb than does the ossifying centre at the lower end of the femur. (Fig. 1097.)

When, after the removal of the diseased ends of the bones, it is found impossible to straighten the limb because of the contracted state of the hamstring tendons, it will be better to perform tenotomy than unnecessarily to sacrifice the bone by making further sections.

When it becomes necessary to carry the incision above the epiphysis, thereby arresting the growth of the limb in length, it has been suggested to remove the epiphysis of the opposite limb in order to make them match. But such an operation will not receive the sanction of a conscientious surgeon.

There is some difference of opinion as to the treatment of the patella in knee-joint excisions. The weight of surgical authority is—very properly, in my opinion—in favor of its removal, thereby diminishing very materially both the risks to life and the probabilities of a subsequent amputation. It can certainly serve no good purpose by remaining, and in disease of the articulation it is liable to suffer in common with the other components of the joint. When the operation is performed for injury, and when this bone is not implicated, the necessity for its removal is not so urgent.

DRESSING.—After ligating such branches of the articular or other arteries as may require a thread, and thoroughly cleansing the wound with sublimated water, drainage-tubes should be placed across the joint, above and below, the bones accurately apposed, and the flap brought down and stitched with sutures to the part from which it was cut. The joint should now be enveloped with the usual antiseptic dressings, and made secure by numerous turns of a roller extending from the foot to the groin.

The proper immobilization of the limb after an operation of this nature is of paramount importance.

An excellent splint can be made of plaster: this must be applied, as all

FIG. 1096.



Joint opened and bones turned out ready to be excised.

FIG. 1097.



Section of the lower end of the femur and the upper end of the tibia, so as not to encroach on the cartilaginous union of the epiphyses with the diaphyses.

others should be, while the patient is under the anæsthetic, though it is best to have the plaster splint or trough prepared before the operation. To do this, the limb, while evenly supported in the extended position, is covered with a roller from the foot to the groin, after which a sufficient number of plaster bandages must be applied to form a stiff splint. As soon as these wrappers become stiff, they should be slit up over the front of the limb, to provide for any subsequent swelling which may occur. On each side, also, above and below the knee, the splint must be cut down so as to form sides which may be raised or lowered at pleasure and by means of which the wound can be dressed without disturbing the limb. (Fig. 1098.) A small

FIG. 1098.



Limb suspended in a plaster splint, its sides let down preparatory to changing dressing.

opening will also be required posteriorly for the accommodation of the drainage-tube. If, now, strips of strong muslin be passed beneath the splint, and the limb be suspended, we have an appliance which secures to the parts the most perfect quiet possible. Under the most favorable circumstances recovery will be tardy, requiring for its completion from eight to nine months.

Professor Ashhurst prefers a bracketed wire splint (Fig. 1099), by which

FIG. 1099.



Ashhurst's wire splint.

great convenience is afforded for the inspection and dressing of the wound. Other splints are used, such as Butcher's box, and the apparatus of Price (Fig. 1100), which resemble the bracketed splint employed by Ashhurst and Packard. Watson, of Edinburgh, applies a splint to the back of the limb, and, by means of a rod in front, suspends the extremity, somewhat after the plan of Nathan R. Smith.

The average duration of the treatment varies in different cases. In 88 of the cases tabulated by Hodges it was about eight months, and was influenced

very much by the presence or absence of the patella, being, in 48 cases in which that bone was removed, 225 days, and in 38 cases in which it was

FIG. 1100.



Price's bracketed splint.

allowed to remain, 255 days. There are, however, many exceptions to this prolonged progress of cure,—instances, indeed, in which quite firm consolidation has taken place in two months.

In order to determine the position which excision of the knee-joint should occupy as a resort of conservative surgery, it will be necessary to make a careful analysis of such data as may be at our command, by comparing excision with amputation.

Hodges's tables contain 208 cases of excision of this articulation, 178 of which were performed for disease. Of this latter number, 102 (about 57 per cent.) proved unsuccessful,—the patients either dying or being compelled, afterwards, to submit to amputation. Of the remaining 106, there were 65 which resulted in useful limbs, 14 operations proved either partly or entirely useless, and 27 had unknown or doubtful result.

Of 19 cases of knee-joint excision at St. Thomas's and St. George's Hospitals, London, reported by Mr. Holmes, a useful limb was reported in 10 cases; of which 9 were children,—the subjects most proper for the operation. About 52 per cent. of these excisions, therefore, were favorable to the operation.

Dr. Wolff, of Berlin, gives a case of successful resection of the knee for articular caries in a child, attended with reproduction of bone.*

Mr. Swain, the author of a "Prize Essay" on excisions of the knee-joint, tabulated 472 cases, with 356 recoveries. Among the recoveries are counted 54 which subsequently underwent amputation, 41 of whom got well and 13 died. The total number of deaths was 116, or a mortality of 24.57 per cent. The accuracy of these tables has been challenged by both Holmes and Bryant, and most justly so. No one for a moment, in the light of more recent statistics, can believe that 302 useful limbs were obtained in 356 recoveries. There is no evidence that many of the cases placed to the credit of the latter were kept under observation for any extended length of time with a view to ascertain whether all the sinuses healed and permanent consolidation followed. And, besides, as Mr. Bryant has pointed out, among the recoveries after excision are enumerated 51 cases of secondary amputation, in which are included both fatal and non-fatal terminations. Again, when the mortality in these tables is studied in a particular class of patients (*e.g.*, those in adolescent life), it is found to amount to 27.8 per cent.,—there being 27 deaths in 97 cases of excision,—whereas in the thigh amputation for chronic disease in young persons of a like age, out of 69 cases 3 only proved fatal, or 4.3 per cent., according to Bryant's collection. If we extend the comparison between the two operations done for chronic joint disease to the class of patients between twenty-one and forty years of age, the same writer found that in excision the fatality amounted to 52.7 per cent., or 1 in 2,—39 dying out of 74 cases; while in amputation the death-rate amounted to only 32 per cent.,—38 dying out of 119 cases.

In 1869, Pénierès tabulated 431 cases of knee-joint excision, 300 of which recovered, or a death-rate of 30 per cent. Of this number, 247 got well

* Archiv für Klin. Chirurgie, Bd. 20, p. 771, Berlin, 1877.

without any additional operation, 47 by secondary amputation, and 6 by a second excision. The results in these 247 cases were as follows: in 166 the result was good, and in 27 bad. If now we compare the results furnished by this table (which is exceptionally good) with the results in exactly the same number of amputations embraced in the collection of MacCormac and Bryant, it will be seen that the advantage, though small, is still in favor of amputation,—there being 335 recoveries in 431 amputations, or a death-rate of 22 per cent.

Culbertson, in his "Prize Essay" in the American Medical Association Transactions for 1877, tabulates 745 cases of excision of the knee-joint, with 240 deaths, or a mortality of 32 per cent. An analysis of these cases gives the following result:

Excision for Gunshot Wounds.

Partial.....	17 cases.	12 died.	75 per cent. mortality.
Complete.....	44 "	33 "	75 " "
Total.....	61 "	45 "	75 " "

The death-rate following amputation at the lower third of the thigh, in military practice, according to Macleod, is 50 per cent. Legouest estimates it at 55 per cent. For amputation of the thigh in general, it amounted, in the late American war, to 73.23 per cent. The evidence, therefore, in this comparison is against excision.

Excision for Injury other than Gunshot.

Partial.....	12 cases.	4 deaths.	33 per cent. mortality.
Complete.....	16 "	7 "	45 " "
Total.....	28 "	11 "	39 " "

The injuries for which the excision was done were compound luxations, compound fractures of the patella, with lacerated wounds, and compound fractures of the condyles of the femur, with extensive disorganization of the joint.

Norris gives 40 amputations of the thigh in the Pennsylvania Hospital, performed on account of injury, with 26 recoveries and 14 deaths, or a death-rate of 35 per cent. This does not materially differ from the mortality attending such operations in other hospitals, which will be found to range from 35 to 57 per cent. The result here is favorable to excision in injuries of the nature just stated:

Excision for Disease.

Partial.....	18 cases.	4 deaths.	22 per cent. mortality.
Complete.....	585 "	174 "	30 " "
Total.....	603 "	178 "	31 " "

[Of these 603 excisions, 78 were afterwards subjected to amputation, with 65 recoveries, 12 deaths, and 1 undetermined result; which, with 6 undetermined excisions, would make the death-rate really 31 per cent.]

The combined collections of amputations of the thigh for disease, tabulated by Bryant and MacCormac, number 431 cases, 335 recoveries, and 96 deaths,—a mortality of 22 per cent. This result is unfavorable to excision.

In Hodges's tables are 178 cases of excision executed for disease. Of this number, 108 recovered and 70 died,—a death-rate of 39 per cent., or 17 per cent. in favor of amputation over excision.

Excision for Deformity.

Partial.....	14 cases.	2 deaths.	14 per cent. mortality.
Complete.....	39 "	5 "	13 " "
Total.....	53 "	7 "	13 " "

In this class, it will be noticed, the greatest success for excision was obtained.

In the calculations of the percentage, all the cases in which the extent of the operation was not recorded were disregarded.

The influence of age in determining the results of excision of the knee-joint, in cases operated upon for disease and injury, has been carefully analyzed by Culbertson. The data show that the fatality is greatest in the very young and the aged. Thus, in 19 cases, in which the subjects were from one to five years of age, the mortality was 38.9 per cent.; in 106, between five and ten years, it was 16.2 per cent.; and in 99 cases, between ten and fifteen years, it was 17.2 per cent. From the last period of life upward there was a very rapid increase in the death-rate, which amounted, in patients over forty, to 52.6 per cent.

Mr. Willett, in the St. Bartholomew tables, gives 38 cases of knee-joint excision, with 8 deaths, or 21.05 per cent. of mortality; and Mr. Sydney Jones gives 10 cases, with 3 deaths, or a death-rate of 30 per cent. To these cases we may add 27, reported in 1873,* 5 of which ended fatally, with 1 secondary amputation, or 20 per cent. of failure; and 40 cases given by Sir W. Fergusson, done for osseous ankylosis, 30 of which recovered and 10 died,—a death-rate of 25 per cent.

According to the statistics compiled by Mr. Knoll,† out of 104 knee-joint excisions, performed exclusively by German surgeons, 52, or 50 per cent., died. Drs. Drake and Fenwick‡ have reported 5 cases of excision of the knee-joint for disease, with 4 recoveries and 1 death. The general rate of mortality for this excision, deduced from all the data furnished by the different writers quoted, may, therefore, be approximately set down at 32.4 per cent.

The great fatality of knee-joint excisions for shot injury in military as compared with civil practice will further appear by again referring to Spillman's collection of cases. This writer gives 13 instances of this operation in civil practice, performed for gunshot wounds, with 3 deaths, or a death-rate of 39 per cent.; while in 21 similar injuries in military practice, 19 proved fatal,—a death-rate of 90 per cent.

Of the 11 cases of this excision performed during the late American war, 9 died,—a mortality of nearly 90 per cent.

Dr. S. W. Gross has tabulated 35 cases of knee-joint excision for gunshot injury, 11 of which recovered and 24 died,—a death-rate of 68.57 per cent. The complete excisions proved more fatal than those which were partial by 33 per cent. And the primary were more successful than the secondary operations, the difference being 10 per cent. in favor of the primary.

The modern method of dressing wounds must necessarily greatly reduce the mortality of excisions. From 1874 to 1886 inclusive, there were 115 excisions performed in Esmarch's clinic, with only 6 deaths, 5 after excision and 1 after secondary amputation. Ollier, since 1885, has had only 1 death in 26 excisions, and 48 cases of elbow-joint excision without a death attributable to the operation.§

Deductions.—The deductions which may be legitimately drawn from the analysis of the foregoing collections of knee-joint excisions may be formulated as follows:

(1) That, in military practice, this operation should, in a considerable proportion of cases, be abandoned, and amputation substituted for it.

(2) That there remains a large class of cases, consisting of compound luxations, lacerated wounds of the joint, and of chronic disease, which occupies debatable ground, the treatment of which, by excision or by amputation, can only be decided on a careful consideration of the individual cases.

* New Sydenham Society's Biennial Report for 1873-74, p. 281.

† Dissert. Inaug., Leipsic, 1866.

‡ Canada Medical and Surgical Journal, 1878, vol. vi. pp. 261-269.

§ Annual of Universal Medical Science, 1889, vol. iii. p. 12.

being held aside, the internal malleolus may be cut away by the bone pliers, or the internal lateral ligament may be first divided, by shaving round the end of the malleolus.

Clearing the bone now, in front and behind, with the handle of the scalpel, or the finger, and strongly everting the foot, the tibia and the upper surface of the astragalus will be exposed at the internal wound. A narrow-bladed saw must now be entered through the internal wound, passed behind the tibia, and made to appear at the external opening, when the bone can be divided from behind forward. This done, the upper surface of the astragalus may be sawn off. If the disease has penetrated deeply into the substance of the latter bone, its entire excision will be indicated.

DRESSING.—One or two small arterial branches will probably require the ligature. After this is done, the wound must be thoroughly washed out with sublimated water; a drainage-tube passed through from one side to the other of the joint; the sides of the incision closed by the interrupted suture; and an antiseptic dressing applied.

To secure perfect quiet, and a proper position of the foot,—namely, the normal one,—a plaster splint should have been prepared previous to the operation, sufficiently large to allow for the antiseptic dressing. Into this splint the foot and leg should be placed, and held by an assistant until the *apparel* is secured by means of an aseptic roller. If preferred, traps may be cut on the inside and the outside of the plaster splint; or it may be slit down on each side, so that the pieces may be lowered or elevated at pleasure, and thus admit of the interposition of absorbent cotton, an article well adapted to absorb the discharges issuing from the wound.

On the second or third day following the operation the sides of the plaster splint should be let down and the parts carefully examined. If there is no great discharge from the wound, and no rise of temperature, it will not be necessary to renew the dressing.

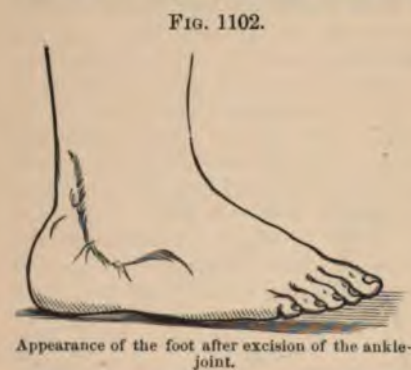
When suppuration occurs, the accumulation can readily be washed out by fitting the nozzle of a syringe to the drainage-tube and injecting into the cavity of the wound a stream of tepid sublimated water or a solution of the permanganate of potash.

In the absence of the materials for the plaster dressing, the foot and the leg should be placed in a fracture-box; and, to secure greater quiet, the box should be suspended, as in Fig. 860, vol. i. page 1028. The plaster splint may be suspended in the same manner.

If the operation is done antiseptically, it will seldom be necessary, after the first dressing, to renew the latter oftener than once in from five to seven days.

The *constitutional treatment* must be guided by the necessities of the case. Anodynes may be administered freely if there is much pain. In order to provide against the exhaustion of the system, an ample supply of nutritious food, together with tonics and stimulants, will be necessary after the first few days.

By the old plan of treating wounds, the length of time requisite to accomplish a cure, provided the case does well, will vary from three to five



months. This period, however, when the case has been conducted with careful attention to all antiseptic details, will generally be shortened at least one or two months. Very little deformity can be noticed in the appearance of the foot. (Fig. 1102.)

THE SUBPERIOSTEAL METHOD, as prescribed by Ollier and Langenbeck,

The first excision for shot injury was in 1809, by D. J. Larrey, in Benevento, Spain. Similar operations were done in 1831, by Thedan, of Germany, and Percy, Laurent, and Champion, of France.

The first total resection for shot wounds was performed by J. H. Lakin, of England, October 5, 1855, at Sevastopol. In the United States, the first partial excision for gunshot injury was made by Hodgen, of St. Louis, in 1862; and the first total operation by Surgeon A. A. Barrister, U.S.A., in September of the same year. These excisions are followed by the case of Boute, Troy, N.Y., October, 1862.

In 1857, Cooper, of San Francisco, made the first complete excision in this country in civil practice.

Excision of the Ankle-Joint.

Excision of the ankle-joint has been performed for gunshot injury, for compound luxations, and for disease. The propriety of the operation may, however, be considered as still under discussion.

OPERATION.—To prevent bleeding, the limb, after the patient is etherized, may be emptied of its blood by an Esmarch bandage.

The operation which gives the freest access to the joint is that devised by Mr. Hancock. It consists in first placing the foot on its inner side, and then making an incision along the posterior face of the fibula, commencing three inches above its lower extremity, and, after reaching the end of the malleolus, changing its direction, and terminating about half an inch short of the metatarsal bone of the little toe. The flap is next raised and reflected forward, exposing the surface of the fibula. In doing this, care must be taken not to injure the tendons of the peroneus longus and brevis muscles, which lie against the posterior and outer face of the bone. The fibula must next be cut through with strong bone pliers, and its lower extremity dissected out.

As the joint is now exposed on its outer aspect, it will be proper, before proceeding further, to examine the condition of the articulation. Should the disease be found to be very limited and accessible, this one incision may suffice for its removal; and it answers to the plan directed by Dr. Buchanan, of Glasgow. When, however, this is not the case, it will be necessary to place the foot on its outer surface, and to make a second incision, in form and extent like the first, along the inner angle of the tibia, and terminating at the internal cuneiform bone. (Fig. 1101.) The flap is to be dissected back, observing to keep close to the bone, in order that the tendons of the tibialis

FIG. 1101.



Inner and outer lines of incision.

posticus and flexor longus digitorum muscles, together with the posterior tibial artery, veins, and nerves, may be raised without injury. These parts

being held aside, the internal malleolus may be cut away by the bone pliers, or the internal lateral ligament may be first divided, by shaving round the end of the malleolus.

Clearing the bone now, in front and behind, with the handle of the scalpel, or the finger, and strongly everting the foot, the tibia and the upper surface of the astragalus will be exposed at the internal wound. A narrow-bladed saw must now be entered through the internal wound, passed behind the tibia, and made to appear at the external opening, when the bone can be divided from behind forward. This done, the upper surface of the astragalus may be sawn off. If the disease has penetrated deeply into the substance of the latter bone, its entire excision will be indicated.

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The *constitutional treatment* must be guided by the necessities of the case. Anodynes may be administered freely if there is much pain. In order to provide against the exhaustion of the system, an ample supply of nutritious food, together with tonics and stimulants, will be necessary after the first few days.

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months. This period, however, when the case has been conducted with careful attention to all antiseptic details, will generally be shortened at least one or two months. Very little deformity can be noticed in the appearance of the foot. (Fig. 1102.)

THE SUBPERIOSTEAL METHOD, as prescribed by Ollier and Langenbeck,

FIG. 1102.



Appearance of the foot after excision of the ankle-joint.

differs from the plan already described only in preserving the periosteum, by peeling this membrane from the bones excised, by means of the periosteal elevator. If the surgeon is successful in effecting this detachment in a reasonably perfect manner, a considerable reproduction of new bone may be anticipated, to take the place of that removed. This will not only diminish the shortening consequent upon the operation, but it will also insure a more useful limb.

RESULTS OF ANKLE-JOINT EXCISIONS.—In order to determine the true value of ankle-joint excision, it should be compared in its results with those of expectancy and amputation. The profession is certainly not yet in possession of a sufficient number of facts to settle the question of the relative merits of these methods. If it is decided by the precarious data which are at present within reach of the profession, the class of cases which will justify a resort to excision of this joint is very limited indeed, and I believe this will be the final verdict after the observations shall have accumulated sufficiently to warrant an authoritative decision of the points at issue.

Mr. Stokes has recorded 51 cases of excision of the ankle-joint for disease, 38 of which were reported successful, or about 74 per cent. In 68 cases of this excision, performed for compound fracture and for dislocation, as tabulated by the same writer, 11 died, or nearly 1 in 6; and 4 were subjected to subsequent amputation; so that the operation was a failure in more than 22 per cent. of these cases.

Mr. Hancock reports 32 cases of excision of the ankle-joint for disease. The ages of the patients varied from four to forty-two years. The sexes show the proportion of 16 males to 6 females. Of the 32 patients operated upon, 21 recovered with good and useful limbs; 7 died; 2 underwent secondary amputation, and recovered; and in 2 the result was undecided. The proportion of deaths, consequently, exceeds 21 per cent.; the proportion of known failure is nearly 30 per cent.; and the proportion of favorable results, so far as ascertained, is 65 per cent. It is stated, however, that 4 of the patients who died were suffering with consumption of the lungs, and 1 with syphilitic disease.

Professor Spillman, of France, has published the results of 72 resections of the tibio-tarsal articulation, performed for disease or pathological causes.* Of this number, 43 were reported as successful, and 7 as partially successful; 14 patients died; in 5 cases the termination was not given; and 3 underwent subsequent amputations. Of those who died, it is stated, 3 were suffering from disease other than that of the joint. According to these data, the proportion of failures of the operation is over 23.5 per cent.; the death-rate at least 19.4 per cent.; and the proportion of complete success is not known to have exceeded 60 per cent.

This French author states that 12 of the above-mentioned cases of joint disease had a traumatic origin, and in 11 of these the operation was successful.

In 37 of these resections, which were strictly pathological cases, in which the tibia was involved, there were 22 cures; 1 case in which the disease lingered two years after the operation; 7 deaths; and 7 cases in which subsequent amputation was done, with a fatal result in 2, and a good result in 2; while of the 3 others no note is given,—in fine, 9 deaths, or a death-rate of 24.3 per cent., and 15 unsuccessful operations out of 37, or 40 per cent. of failure.

Of 68 resections, performed for luxations and compound fractures of the tibio-tarsal joint, as enumerated by Spillman in the same publication, 44 were decidedly successful; 6 partly successful; 13 were fatal; 3 doubtful; and 2 underwent amputation. The mortality in this class of cases, according to these statistics, appears to be about 20 per cent.; the proportion of failure in the operation, over 22 per cent.; and that of decided success, 64.7 per cent.

Heyfelder, in 1867, had reported 26 examples of this excision of the ankle

* *Archives Générales de Médecine*, vol. xiii., 1869, p. 155.

joint, of which number 5 died, or about 19 per cent.,*—a mortality corresponding with that deducible from the data of Spillman. Jaeger also reported 24 cases of this excision, 23 of which, it was claimed, had been successful, and 1 had died from the operation. These cases are not taken into account in the final estimate.

In 1873, Heyfelder reported 174 cases of resection (both partial and complete) of the ankle-joint. Of this total number, 151 recovered with a useful limb, and 7 with a useless limb, and 16 of the patients died.† The proportion of failure in these excisions, including those which were partial operations, was, therefore, 13.2 per cent.

Dr. L. Lauff, in a careful dissertation "On the Statistics of Excision of the Ankle-Joint," published at Halle, 1872, records 104 cases (though not all recently performed). Of these, 33 excisions were performed for caries of the ankle-joint, of which only 17 were thoroughly cured (or 51.5 per cent.), and 10 died,—a death-rate of 30 per cent.

Culbertson has tabulated 147 cases of partial, and 7 cases of complete, excision of the ankle-joint, performed for injuries other than gunshot, with 19 deaths, or a mortality of 12.5 per cent.

The same writer has also collected 124 cases of similar excisions executed for disease, of which 68 were partial, 51 complete, and 5 uncertain, with 10 deaths, or a mortality of 8.05 per cent. It appears, however, that 12 per cent. of those done for disease subsequently demanded amputation, making the proportion of failures over 20 per cent.,—a circumstance which materially tells against the excision. The proportion of useful limbs after recovery is estimated by Culbertson at 66 per cent. The proportion of failure, therefore, was 34 per cent.

Between 1850 and 1872, Langenbeck performed 4 subperiosteal excisions of the ankle-joint and os calcis, with the result of very complete reproduction of bone, and in 2 cases the joint recovered excellent motion.

Mr. Holmes, in 1878, reported 7 cases of ankle-joint excision for disease, of which number 1 proved fatal, and 1 called for subsequent amputation.‡ This writer attaches no importance to the preservation of the periosteum. He also strongly advocates the removal of the astragalus entire, a practice which certainly renders a reproduction of the disease less probable.

Dr. Bergmann, of Dorpat, has collected 11 cases of excision of the ankle, with 2 deaths,—a death-rate of 18.18 per cent.

Comparison with amputation.—There are three amputations with which excision of the ankle-joint may appropriately be compared,—viz., amputation of the leg, Syme's amputation, and that of Pirogoff.

1. The average mortality attending amputation of the leg for pathological disease varies from 20 to 25 per cent. If we compare this proportion with the death-rate from excision, as deduced from the most exact data already given from different sources, and which varies from 8.05 per cent. (Culbertson) to 19.4 per cent. (Spillman), the weight of evidence is against amputation, and in favor of excision, for disease of the ankle-joint.

2. Amputation of the ankle-joint, commonly known as Syme's amputation, according to the statistics of Mr. Hancock, who has analyzed 219 such cases, 144 of which were undertaken for disease, with 10 deaths, is attended with a mortality of about 1 in 14 cases, or 6.9 per cent.,—a result which is favorable to amputation.

3. According to the statistics of Butcher, who has examined into the history of 58 cases of Pirogoff's operation (in which 5 proved fatal), the rate of mortality is a fraction over 9 per cent. This result, likewise, is in favor of amputation, and against excision.

For further statistics of the results of amputations, the reader is referred to data hereafter to be given.

* The Lancet, 1867, vol. ii. pp. 121, 122.

† Klinische Vorträge, 1873, cit. London Medical Record, July 16, 1873.

‡ Medical Examiner, March 7, 1878, p. 198, and London Medical Record, May 15, 1878.

But, when instituting such comparisons, there is danger of grave error, unless it be borne in mind that while in amputations the resultant deaths reported generally cover all the cases of surgical failure, it is otherwise in excisions. The proportion of failures in the excisions reported largely exceeds that of deaths. And this excess appears to be especially noteworthy in the excisions performed for causes strictly pathological,—the very class of cases the results of which we are most concerned to ascertain. Thus, for example, in all the excisions done for causes strictly pathological, given by Dr. Spillman, although the death-rate was not reported at more than 24.3 per cent., the failure-rate amounted to no less than 40 per cent. And in the tabulated excisions of every kind given above, where the data are comparable, the failures, as stated, averaged not less than 20 per cent., and the successes claimed do not exceed 70 per cent. Indeed, a safe and crucial analysis of all the figures would justly require us, when the highest proportion of success claimed in all the comparable excisions is only 70 per cent., to set down the general proportion of failures at 30 per cent. These facts are very pertinent in any fair inquiry into the comparative merits of excision and amputation. For, as M. Polaillon, when discussing the statistics of resections of the os calcis, has forcibly urged,* “it is clear that the end of the excision is not only the conservation of the foot, but, moreover, the conserving of a foot useful for standing and walking. If this end is not attained, the result ought to be charged as *bad*.” That these statistics of excisions also give a distorted representation of their comparative value is further evidenced by the fact that the statistics of amputations are immensely more numerous and more accurately reported than those of excisions. The excisions, moreover, have generally been executed in selected cases, by the masters of surgery, and followed up usually by the best treatment, while the amputations have often been done by men of inferior skill, with inferior appliances for securing a successful result.

HISTORY.—Excision of the ankle-joint is a very old operation. As early as 1670, Fabricius Hildanus cut out the entire astragalus in a case of compound luxation. In 1716, Gouey, of France, removed, on account of necrosis, first the lower end of the fibula, and at a second operation the astragalus. The astragalus was again, in 1741, excised by Vonder Broilic, in a case of a luxation attended with an external wound. During the succeeding seventeen years four similar operations were executed, the surgeons being Aubray, Ferraud, J. S. Desault, and Manduyt. In 1782, Cooper, of Bungay, England, removed the tarsal extremity of both bones of the leg for a compound luxation of the foot. Hey, of Leeds, England, in 1776, performed a similar excision for injury, and this was followed, in 1782, by the operations of Kirtland and the elder Moreau. The last-named surgeon, in 1788, removed, for disease, both the astragalus and the scaphoid bone. In 1786, Hey again resected the lower end of the tibia and fibula in a case of compound dislocation. Two years later, Taylor, of Wakefield, England, and Tyre, of Gloucester, each cut away the lower extremity of the tibia on account of injury. In 1792, quite a number of excisions of the astragalus were made by Chorley and Linn, of England, the two Moreaus and Laumonier in France, and Rumsey, of Amsterdam. In Prussia, the first operation of the kind was done by Mulder, of Groningen, in 1810.

The first total excision of the ankle-joint appears to have been made in April, 1792, by the elder Moreau, and in Scotland by Liston, in 1818.

In America, Morrogh, of Clifford, New Brunswick, performed the first complete excision in 1854. In 1859, Forster, of Portland, Maine, removed the end of the tibia and a portion of the astragalus; and the same year a total excision of the joint was done by Cabot, of Boston. As early, however, as 1835, partial excisions of this joint had been performed in this country by Welles, of South Carolina, Stevens, of New York, Gillespie, of Virginia, and Nathan R. Smith, of Baltimore. To these may be added one by Manson,

* Archives Générales de Médecine, September, 1869, p. 259.

of Missouri, in 1839; one by Hildreth, of Ohio, in 1844; one by Robertson, of Charleston, South Carolina, in 1851, and another by Gurdon Buck, of New York, the same year.

The first excision for gunshot injury was executed by a surgeon named Reed, in 1819: the patient recovered after undergoing secondary amputation. In 1855, during the Crimean War, Macleod, of Glasgow, removed the os calcis and a part of the astragalus for a similar injury.

The first total excision for gunshot injury in the United States was performed in 1864, by Bontecou, of Troy, N.Y.

Langenbeck has the credit of making the first subperiosteal excision.

Excision of the Clavicle.

Excision of the clavicle, in whole or in part, may be required on account of morbid growths, intractable luxations, gunshot and other injuries, and for the cure of caries or necrosis.

Except when the bone is involved in a diseased growth, or when the associate parts are united by inflammatory changes, its extirpation is not a difficult task.

OPERATION.—An incision should be made along the course of the bone, extending from its acromial to its sternal articulation. After dividing the superincumbent tissues, including the periosteum, the bone should be shelled out from its surrounding parts by an elevator rather than by a knife.

Its acromial articulation is next to be severed, by dividing the capsular and coraco-clavicular ligaments. The bone should now be seized and pulled forcibly forward, and its remaining attachments divided from the acromial towards its sternal end; and on reaching the latter, the disjunction can be completed by dividing the capsular, interarticular, and costo-clavicular ligaments. The vessels should be tied as the operation progresses.

DRESSING.—After the removal of the bone, the sides of the wound must be brought together by the interrupted suture, and a water or a carbolized dressing applied. This can be best kept in place by a spica bandage of the shoulder. In addition, a pad should be placed in the axilla, and the arm supported by means of a Velpeau roller.

In case of necrosis or of comminution, the extirpation of the clavicle is not an operation of any peculiar difficulty. But, when undertaken for encephaloid, sarcomatous, or other growths, the inflammatory alterations of the adjacent cervical tissues will render the extirpation a tedious, embarrassing, and bloody procedure.

Usefulness of the arm.—The movements of the arm after recovery from the operation have not been seriously impaired; and in some instances the patients have experienced but little diminution of muscular power in the limb, being able to raise and carry heavy weights. In a case in which I removed the entire clavicle at the University Hospital, the bone was reproduced in its whole extent.

HISTORY.—Complete excision of the clavicle was performed as early as 1732, by Remmer, on account of cancer. In this country the bone was first extirpated by McCreary, of Kentucky, in 1811 or in 1813.

The following table, framed from the collection of cases by Otis, and from those recorded in various medical journals, embraces most, if not all, of the cases of complete excision of the clavicle which, so far as I know, have been reported:

Complete Extirpations of the Clavicle.

No.	Operator.	Date.	Cause.	Recovery.	Death.	Reference.
1	McQuary.	1811 or 1813.	Scrofulous necrosis.	1	.....	New Orleans Medical and Surgical Journal, 1850, vol. vi. p. 471. Smith's Principles and Practice of Surgery, vol. ii. p. 335.
2	Meyer.	1823.	Caries.	1	.....	Encyclop. Wörterbuch der Med. Wissenschaften, B. xxix. S. 96, and Graefe and Matthias Jour., 1833, B. xix. S. 71.
3	Volt.	1828.	Osteosarcoma.	1	.....	American Journal of Medical Sciences, 1828, vol. iii. p. 100.
4	Wutzer.	1825.	Caries.	.....	.....	Orsibach, De resectione Claviculae, Bonn, 1833, p. 6.
5	Wutzer.	1832.	Caries.	.....	.....	Orsibach, De resectione Claviculae, Bonn, 1833, p. 6.
6	Warren, J. C.	1832.	Osteosarcoma.	1	.....	American Journal of Medical Sciences, 1833, vol. xiii. p. 17.
7	Roux.	1834.	Caries.	1	.....	Miguel, Bull. Gén. de Thérap., 1834, t. vi. p. 246.
8	Mazoud.	1835.	.....	1	.....	Gazette Médicale de Paris, 1838, p. 460.
9	Travers.	1836.	Tumor following injury.	1	.....	Med.-Chirurg. Trans., 1838, vol. xxi. p. 135.
10	Haugen.	1838.	Necrosis.	1	.....	Gazette Médicale de Paris, 1838, p. 460.
11	Kam.	1838.	Injury.	1	.....	Deutsche Klinik, 1850, B. ii. S. 263.
12	Waldenbarn.	1832.	Caries.	1	.....	New Orleans Monthly Medical Register, 1852, vol. ii. p. 1.
13	Bartlett.	1853.	Exostosis.	1	.....	St. Louis Medical and Surgical Journal, 1854, vol. xii. p. 64.
14	Owens.	1854.	Osteosarcoma.	1	.....	New Orleans Medical and Surgical Journal, 1854-55, vol. xi. p. 164.
15	Blackman.	1856.	Caries.	1	.....	The Western Lancet, 1856, vol. xvii. p. 336.
16	Curtis.	1857.	Malignant disease.	1	.....	American Journal of Medical Sciences, 1857, vol. xxxiv. p. 350.
17	Silston and Richard.	1857.	Caries.	1*	.....	Ollier, Traité expér. et clin. de la Régénér. des Os, Paris, 1867, t. ii. p. 174.
18	Emmich.	1859.	Osteosarcoma.	1	.....	Nissen, Diss. de resectione, 1859, p. 7.
19	Reyfelder.	1860.	Caries.	.....	.....	Deutsche Klinik, 1860, B. xii. S. 291.
20	Gunn.	1860.	.....	1	.....	Chicago Medical Journal, 1868, vol. xxv. p. 301.
21	Confederate surgeon.	1864.	Shot injury.	.....	.....	Medical History of War of Rebellion, 1870, Part I. vol. ii. p. 557.
22	Palmer.	1864.	Shot injury.	1	.....	Medical History of War of Rebellion, and American Journal of Medical Sciences, 1865, vol. xlix. p. 367.
23	Bow.	1866.	Caries.	1	.....	Medical Times and Gazette, 1866, vol. ii. p. 194.
24	Irvine.	1867.	Necrosis.	1	.....	Lancet, 1867, vol. i. p. 200.
25	Morn.	1868.	Malignant disease.	1	.....	Gazette Médicale de Lyon, 1868, No. 8, p. 93.
26	Dewson.	1868.	Necrosis.	1	.....	Cincinnati Lancet and Observer, 1868, vol. xi. p. 1.
27	Osby.	1869.	Osteosarcoma.	1	.....	Leavenworth Medical Herald, 1869, vol. iii. p. 302.
28	Verick.	1870.	Tumor.	1	.....	New York Medical Record, 1870, vol. iv. p. 510.
29	Eze.	1870.	Malignant disease.	1	.....	Nashville Journal of Medicine and Surgery, 1871, vol. i. p. 68.
30	Britton.	1870.	Malignant disease.	1	.....	Medical Times and Gazette, 1870, vol. i. p. 551.
31	Langenbeck.	1870.	Malignant disease.	1	.....
32	Cooper.	1870.	Malignant disease.	1	.....
33	Forquet.	.....	Caries.	.....	.....	L'Année Médicale, May, 1877.
34	Canwell.	1874.	Necrosis.	1	.....
				22	6	6 results undetermined.

* Lived one year.

There were of the whole number 22 recoveries, 6 deaths, and 6 terminations unknown, which gives a mortality of about 17 per cent.

As regards the causes for which these operations were performed, they were—

Caries.....	10
Necrosis.....	5
Osteosarcoma.....	5
Malignant disease.....	6
Shot injury.....	2
Exostosis.....	1
Tumor.....	2
Injury.....	1
Unknown.....	2
Total.....	34

Of 31 cases of *partial excision*, practiced during the late American war for gunshot injury, uncomplicated by wound of the lung, 23 recovered, 6 died, and in 2 the result was undetermined.

Of 4 cases complicated by lung injury, 3 died and 1 recovered. One case complicated by wound of subclavian artery died. One case for necrosis following simple fracture recovered.

The following is a collection of 38 cases of partial excision of the clavicle:

For necrosis.....	6 cases.	5 recoveries.	...	1 undetermined.
" shot injury.....	13 "	11 "	2 died.	...
" caries.....	5 "	5 "	...	...
" disease.....	3 "	3 "	...	...
" osteosarcoma.....	3 "	3 "	...	...
" compound luxation.....	1 "	1 "	...	...
" osteitis.....	1 "	1 "	...	...
" cancer.....	1 "	...	1 "	...
Cause not stated.....	5 "	5 "	...	...
Total.....	38 "	34 "	3 "	1 "

Dr. Schneider, of Königsberg, has reported* (1877) a case of subperiosteal section of a piece of the clavicle an inch and a half long, with five ribs, for gunshot injury with much laceration of the lung; and Dr. Varick, of Jersey City, has reported† a second case of a similar operation (the patient recovering with a firmly ossified clavicle and excellent use of the arm), with a collection of seven other cases of subperiosteal resection of the clavicle, followed by partial or entire reproduction of the bone.

Excision of the Scapula.

Excision of the scapula may be rendered necessary by reason of caries, necrosis, morbid growths, shot wounds, and other forms of injury. The scapula may be removed alone, or in conjunction with the clavicle and the arm,—the latter being an extirpation of the entire upper extremity.

ACROMION PROCESS.—When this part of the scapula demands removal for caries, the bone should be exposed by an incision extending from the clavicle back to where this process terminates in the spine, detaching, by means of the elevator, the periosteum along with the attachments of the deltoid and trapezius muscles. The clavicle should now be separated at the place of its articulation with the acromion; or, if it participates in the disease, it may be divided by the saw at a point where its structure remains sound. The next step is to sever the coraco-acromial ligament, when the diseased bone can be cut away either by the saw or by the bone pliers.

TOTAL EXCISION.—The method of excising the scapula must necessarily be modified by the condition of the soft parts and the character of the disease or injury. Ordinarily, the bone will be best exposed by making two incisions, one extending from the acromion process outward as far as the upper angle, or the upper extremity of its vertebral border; and the other beginning at the centre of the first incision and extending directly downward to a point on a level with the inferior angle of the bone (presenting a T-shaped figure). The flaps, consisting only of skin and subcutaneous tissue, are next to be reflected backward and forward, when most of the muscles connecting the arm with the scapula and the scapula with the body will be brought into view. The trapezius must now be detached from its connection with the spine of the scapula above, and the deltoid from the same eminence below. Those detachments effected, it will be necessary to divide the insertion of the levator anguli scapulæ, together with the two rhomboid muscles, from the upper angle and the vertebral border of the bone.

At this stage of the operation the posterior scapular artery will be cut, and should be immediately secured. Raising the inferior angle of the scapula, the surgeon will now be able to sever the origin of the serratus magnus and teres major muscles, at the same time separating the latissimus dorsi from its connection with the lower angle of the bone.

* See American Journal of the Medical Sciences, October, 1878.

† New York Medical Journal for 1878, p. 52.

The clavicle may be next detached from the acromion, or, preferably, this process may be sawed through posterior to the acromio-clavicular articulation, and the latter allowed to remain.

The last stage of the operation consists in sawing through the neck of the scapula by means of a chain or other saw, and removing the bone, thus leaving the scapulo-humeral articulation undisturbed.

If, however, this plan is rendered impossible by the circumstances of the case, and it is deemed necessary to take away the bone in its totality, the lower end of the scapula should be raised upward in the direction of the neck, when the coracoid process can be freed from its muscular and other connections, the capsule of the joint can be divided, and likewise the scapular muscles, which are connected with the tuberosities of the humerus.

THE SUBPERIOSTEAL METHOD.—When the scapula is removed on account of caries, the subperiosteal method of Ollier should be adopted. This latter operation may be divided into three stages,—the formation of flaps, the denudation of the bone, and the disarticulation.

The first, or formation of flaps, is accomplished by two incisions, the one following the line of the posterior border of the scapula from its upper to its lower angle, and the second extending over the spine of the bone from the acromion process backward and slightly downward, until it joins the first incision. (Fig. 1103.)

After reflecting the flaps and severing the attachments of the trapezius and deltoid from the acromion and spine, the operator divides the periosteum over the vertebral border of the scapula, and, applying an elevator, commences the separation of the periosteum from the infra-spinous fossa. When the lower angle of the bone is reached, the *teres major* and *latissimus dorsi* muscles are detached.

The elevator is then applied to the under surface of the scapula, raising the periosteum from the subscapular fossa, and with it the *serratus magnus* and *subscapularis* muscles.

The supra-spinous fossa is next treated in a similar manner, in doing which care must be taken not to damage the supra-scapular nerve, where it traverses the supra-scapular notch.

The lower part of the scapula should next be raised, in order that the whole of the venter and the anterior part of the bone may be cleared. Here, as in the operation first described, if the disease or injury will allow, the neck of the scapula may be divided, and the glenoid cavity, with the coracoid process, be allowed to remain.

If this is not allowable, the third and last stage of the operation can be completed by disarticulating the acromion process from the clavicle, turning the scapula strongly upward, and, after dividing the capsular ligament from below, severing the muscular and ligamentous attachments of the coracoid process.

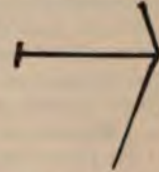
After the extirpation has been effected, and all bleeding has been controlled, the flaps are to be brought together by silver sutures, a drainage-tube having been previously inserted in the wound.

DRESSING.—The usual water or carbolized dressing is applied, and made secure by means of a spica roller of the shoulder; the hand and arm must be kept supported in a sling.

Even when the extirpation of the scapula has been complete, the arm has preserved, to a very extraordinary degree, most of its movements, except that of abduction.

HISTORY AND RESULTS.—Excision of the scapula, leaving the arm undisturbed, was proposed by Liston in 1819, and first performed by Langenbeck* in 1855, in the case of a boy suffering from osteoid cancer. An operation of this kind is said to have been performed by Cumming in 1808; but I am unable to establish its verity. In 1850, Gross removed the largest portion of

FIG. 1103.



Lines of incision for exposing the scapula.

* Deutsche Klinik, 1855, No. 38.

the scapula, leaving only the acromion process and the neck, with the glenoid cavity and the coracoid process. In 1856, Syme removed the scapula, and again, in the following year, on account of a tumor involving the bone, in a female seventy years of age. The same year (1856) witnessed a like operation done by Pirrie. In 1857, Heyfelder* excised, unsuccessfully, this bone for caries. Jones, of Jersey, performed this operation for caries in 1858.† In 1860 two extirpations of the scapula were done, one by Hammer and the other by Schuh. In 1868, Dr. Stephen Rogers, of New York, published a tabulated account of 56 cases of this excision, with an important memoir of the operation.‡ Of these, 24 were excisions of at least three-fourths of the scapula, 16 of which were reported as having been followed by a good use of the corresponding arm, or about 66 per cent. Of 45 cases of partial excision noted by the same author, the death-rate was 22.2 per cent. In 1859, Petrequen, of Lyons, excised the scapula, separating the bone from the acromion process and at its neck. In 1860, Michaux, of Louvain,§ gave an extended memoir on this operation, at the same time recording a temporarily successful case of his own, in a lad aged fifteen years. In 1861, Walters, of Pittsburg, published an interesting case of this excision, in which, as in those of Gross, Petrequen, and Michaux, the scapula was extirpated through the neck and the acromion process. Wolcott has performed a similar operation.

These operations were followed by those of Bird, in 1863,—in which the head of the humerus and a portion of the clavicle were also cut away at two operations; of Hamilton,|| in 1864; of Rogers, in 1867; of Schuppert, of New Orleans, in 1868; of Pollock, in 1870; of Esmarch, in 1870; of Steele and Michel, in 1871; and of Logan,¶ in 1872.

To these cases may be added two excisions by Spence, in 1872, one executed the same year by King, also two by O'Grady, and one by Crawford. In 1874, Schneider,** of Königsberg, reported a case in a boy six and a half years old, in which death occurred four and a half months after the operation from a recurrence of the disease. Next come the cases of Wood, MacCormac†† (1875), Omboni‡‡ (1875), Péan§§ (1877), Gundrum|||| (for gunshot) (1877), Peters.¶¶ Mazzoni,*** Billroth,††† Brigham,‡‡‡ and Orłowski§§§ (all in 1878), Mikulicz||||| (1879), and lastly those of Jones, Bellamy, Nixon, and myself.¶¶¶

Excluding the cases of Gross, Petrequen, Walters, and Wolcott, which were partial, there remain 42 cases of total excisions of the scapula, in 32 of which recovery followed, leaving 8 deaths, and 2 results undetermined. The death-rate in these cases is, therefore, 20 per cent.

Otis has tabulated 49 cases of partial excision of the scapula performed during the late American war, on account of gunshot injuries. Very few of this number could be strictly termed excisions, as in many instances only small portions of the bone were picked away through the wound, merely enlarging the latter. The terminations of these cases were as follows: 23 of

* Deutsche Klinik, 1857. † Med.-Chirurg. Transactions, vol. xlii. p. 7.

‡ American Journal of the Medical Sciences for October, 1868, p. 359.

§ Gazette Médicale de Paris, 1866 (Nos. 16, 17, 18).

|| Medical and Surgical Reporter, 1866, vol. xiv. p. 372.

¶ Richmond Medical Journal, 1872, vol. xiv. p. 131.

** Berliner Klinische Wochenschrift, No. 31, 1874 (cit. London Medical Record, October, 1874, p. 667).

†† St. Thomas's Hospital Reports, vol. vii., 1876.

‡‡ Raccoglitori Medico, January 30, 1875.

§§ Lancet, July 28, 1877.

|||| American Journal of the Medical Sciences, July, 1878.

¶¶ American Journal of the Medical Sciences, July, 1878, p. 100.

*** Gaz. Med. di Roma, vol. iii. No. 6; also New York Medical Journal, 1878, p. 551.

††† American Journal of the Medical Sciences, 1878, p. 275, and London Medical Record, March 15 and May 15, 1878.

‡‡‡ Boston Medical and Surgical Journal, April 11, 1878.

§§§ Centralblatt für Chirurgie, 1878.

||||| Wien. Med. Bl., 1879, vol. ii. p. 45.

¶¶¶ Dr. Kilburne King has twice excised the scapula for malignant disease, once successfully and once with a fatal result, but I have not been able to discover whether the operations were total or partial excisions. See Liverpool and Manchester Medical and Surgical Reporter, vol. iv. pp. 68-70.

the operations were primary, with 6 deaths; 14 intermediary, with 6 deaths; 2 secondary, with no deaths; and 1 death among the unclassified cases, —making in all 13 deaths, or 27 per cent. Of the 36 survivors, 24 were discharged, and 12 returned to full or modified duty.

Dr. Von Adelmann, of Dorpat, at the Seventh Congress of the Society of German Surgeons, held at Berlin, April, 1878, in a paper* there read, gave 61 cases of complete extirpation of the scapula, which he had collected from various sources, drawing from the analysis conclusions quite favorable to the operation.

It would appear that total excisions of the scapula prove less fatal than those which are partial. This conclusion is reached by Rogers, Schneider, and Jones.

In cases of enchondroma, caries, necrosis, and injury, the excision of the scapula, entire or in part, comes legitimately within the sphere of operative surgery; but when undertaken for the cure of malignant disease the propriety of such a procedure is very questionable indeed. And this opinion is formed after having carefully analyzed the results of operations executed for this purpose.

EXCISION OF THE SCAPULA FOLLOWING AMPUTATION AT THE SHOULDER-JOINT.—This operation has been practiced eleven times, the operators being Mussey,† Rigaud,‡ Fergusson (1867), Langenbeck,§ Buck, Busch, Krakowizer, Stimpson, Jeaffreson|| (1873), Soupart,¶ and Deroubaix.** The results of these operations were 6 recoveries, 4 deaths, and 1 result unknown. Logan,†† in 1872, removed the scapula, on account of disease of the bone, after a previous excision of the head of the humerus, the patient making a good recovery.

Excision in the Continuity of the Humerus.

Excision in the continuity of the humerus has been performed on account of shot or other injury attended by comminution, on account of disease, and also for pseudarthrosis.

OPERATION.—In excising the humerus, an incision should be made along the outer aspect of the arm and through the intermuscular fissure which separates the biceps from the deltoid and triceps muscles. At the lower part of the arm, the operator must be careful not to get between the brachialis anticus and supinator muscles; otherwise the radial nerve will be exposed to injury. Hence, in prolonging the incision downward, it is necessary to keep close to the external border of the biceps muscle.

On reaching the bone, the periosteum should be divided, and, by means of an elevator, separated from its osseous connections. The diseased humerus can then either be pulled away with strong forceps, or, if this cannot be readily accomplished, it can be cut away with a chain-saw.

Few blood-vessels will require the ligature, and the wound must be closed by interrupted sutures, a drainage-tube having been previously inserted. The entire limb can then be supported either on an internal angular splint, or on a leather or a felt trough-splint. The plaster roller, applied by recurrent turns, will also serve the same purpose very well.

RESULTS AND INDICATIONS.—During the late American war, excisions for shot wounds were much less successful than the treatment by expectancy; the death-rate in the former being 28.5 per cent., and in the latter 15.2 per cent.†† Non-union of the bone was a very frequent occurrence after these excisions; and the mortality was 12 per cent. greater than that following amputation

* London Medical Record, May 15, 1878.

† American Journal of the Medical Sciences, Philadelphia, 1837, vol. xxi. pp. 390-394.

‡ Edinburgh Medical Journal, November, 1874, p. 467.

§ Archiv der Klinische Chirurgie, 1862, B. iii. 306.

|| Lancet, vol. i., 1874.

¶ Annales de la Société Médicale de Gand, 1857, xxxv.

** Gazette Médicale de Paris, 1866, tom. xxi. p. 277.

†† Richmond Medical Journal, 1872, vol. vi. p. 144.

‡‡ See vol. I. p. 249, Surgical History of the War.

of the arm. These facts are sufficient to condemn excision for gunshot fractures of the bone.

Of 169 cases of excision of the shoulder, collected by Professor Heyfelder, of St. Petersburg, performed as well for disease as for injury, 30 were fatal,—a death-rate of 18 per cent. Dr. Bergmann, of Dorpat, has published 15 cases of this excision, with 3 deaths, or 20 per cent. Hodges gives 50 cases, done for disease only, with 8 deaths, or 16 per cent.

When the humerus is the seat of either acute or chronic necrosis, excision will be proper; as it also will be in cases of ununited fractures, after other and less dangerous measures for securing the consolidation of the bone have failed.

In every case the periosteum should be preserved, and, when the operation is performed for pseudarthrosis, the probability of success will be enhanced by wiring together the ends of fragments. When the periosteum has been retained, the reproduction of a new bone answering to the part removed may be expected.

Even when the entire diaphysis has been resected, as in Langenbeck's, Ollier's, and Wilkes's cases, a new bone has been formed. Dr. Cutter, of New Jersey, in a case of necrosis, excised not only the entire humerus, but also the upper extremity of the radius and ulna, obtaining, finally, a reasonably good arm.

When, however, the disease transcends the limits of the diaphysis, making it necessary to include the epiphysis in the resection, and when the periosteum cannot be preserved, it will be better to amputate. For otherwise the limb will be left hanging like a flail, and will prove an incumbrance rather than a useful member of prehension.

Excision of the Bones of the Forearm.

Excision of one or of both bones of the forearm may become necessary on account of necrosis, myeloid and other tumors, and in cases of ununited fracture. The operation has been executed for gunshot injury, but with poor results.

OPERATION.—If the ulna is to be removed, the incision should be made along its inner border, entering the fissure between the flexor and extensor carpi ulnaris muscles.

When the radius is to be the subject of operation, the bone is most satisfactorily exposed by a cut made along its posterior surface, external to the supinator muscles.

After incising the periosteum and peeling it away from the bone, the latter may be divided, either by a pair of strong cutting pliers or by the chain-saw.

If the excision is partial, and limited to one bone, the probability of non-union is much greater than when both bones are resected.

One bone may be wholly removed and yet a useful forearm remain.

DRESSING.—After the operation is completed, and the wound is closed by interrupted sutures and covered with a carbolated oil dressing, the limb should be lightly secured to an internal angular splint.

The results following formal excisions in the continuity of the radius and the ulna, during the late civil war, for shot wounds, were so uniformly bad that the operation merits unqualified condemnation. In 40 partial primary excisions of both the radius and the ulna, 34 patients recovered with useless limbs, and a number of these only after amputation.

HISTORY.—Heyfelder states that Bilguer, Saint-Hilaire, and Fricke were among the first to resect portions of the radius and ulna in their continuity for shot injuries. In this country, Dr. Fahnestock, of Pittsburg, in 1840, recorded the first instance of excision of the shaft of the radius on account of shot injury.*

* American Journal of the Medical Sciences, 1840, vol. xxvi. p. 91.

A resection of the shaft of the ulna, for disease, is ascribed by Velpeau to Scultetus, as early as 1675.

Partial excisions of these bones, on account of ununited fractures, were done by Fricke, in 1828, by Holscher, in 1830, and by Dr. Thomas Harris, U.S.N., in 1833. Similar operations were executed for compound and compound comminuted fracture, by Hublier, in 1829.

In 1853, Carnochan resected the entire ulna. Similar operations were performed by Mr. Jones, of Jersey, England, and by Dr. Muscroft, of Cincinnati. Butt, of Portsmouth, Virginia, removed the lower three-fourths of the ulna, in 1825, with an excellent result. Bell, of Edinburgh, and Hutchison, of New York, have excised the entire ulna. Raklitsky, Surgeon-in-Chief of the Morskoy Hospital, St. Petersburg, in 1837, removed the whole of the diaphysis of the radius. A similar operation was performed by Erichsen and by Carnochan, in 1854. Compton, of New Orleans, in 1853, excised portions of the radius and the ulna in its entirety. All of these cases recovered, it is said, with very useful hands.

A number of cases have been recorded in which the lower extremities of both the radius and the ulna have been removed on account of caries or morbid growths, leaving a useful hand. Among these may be mentioned those of Mr. Hancock and of Mr. Morris. In one case Erichsen removed the elbow-joint and the greater part of the radius at the same operation; and Williamson has excised the entire ulna along with the elbow-joint.

In a case of scrofulous disease, Professor Gross resected the upper half of the radius along with the external condyle of the humerus. I have made several partial excisions of these bones on account of compound fractures, caries, and morbid growths, and with the most satisfactory results.

Excision of the Bones of the Lower Extremity in their Continuity.

Excision of the Femur.—Partial excisions of the femur, in cases of compound comminuted fractures, and for pseudarthrosis, have occasionally been executed. Such operations are attended with great danger; and, except when done for compound comminuted fractures, they should be discarded from surgical practice. The removal of the shaft of the femur to any great extent, unless the union of the remaining ends could be secured, would render the limb both useless and an incumbrance.

Excision of the Trochanter Major.—The trochanter major has, in a few instances, been excised when attacked by necrosis; and when the disease is limited to this portion of the bone—a very rare occurrence—the operation is entirely proper. The first excision of this kind was done by Tenon, as early as 1798; it has been repeated in England by Teale and Fergusson, in France by Velpeau, in Germany by Textor and Heyfelder, and in America by Parker.

Operation.—A director should be passed through one of the sinuses down to the diseased bone, when, by enlarging the opening, the necrosed portion may be extracted. If a more formal procedure is required, as when the fistulous orifices open upon the surfaces of the thigh, remote from the seat of the disease, an incision may be made parallel with and along the posterior border of the process, when, by clearing away the soft parts from the trochanter major, the necrosed portions can be reached by the bone forceps or gouge.

Before closing the wound the drainage-tube should be introduced, and its end brought out at the lower angle of the incision.

Excision of the Patella.—The patella, though requiring removal in cases of knee-joint excision, is rarely independently affected with disease.

The operation, however, has been practiced in a number of cases on account of caries, compound comminuted fracture, and also for shot injury.

Heyfelder's collection embraces 11 cases, with 9 recoveries and 2 deaths.

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DRESSING.—After the operation is completed, and the wound is closed by interrupted sutures and covered with a carbolated oil dressing, the limb should be lightly secured to an internal angular splint.

The results following formal excisions in the continuity of the radius and the ulna, during the late civil war, for shot wounds, were so uniformly bad that the operation merits unqualified condemnation. In 40 partial primary excisions of both the radius and the ulna, 34 patients recovered with useless limbs, and a number of these only after amputation.

HISTORY.—Heyfelder states that Bilguer, Saint-Hilaire, and Fricke were among the first to resect portions of the radius and ulna in their continuity for shot injuries. In this country, Dr. Fahnestock, of Pittsburg, in 1840, recorded the first instance of excision of the shaft of the radius on account of shot injury.*

* American Journal of the Medical Sciences, 1840, vol. xxvi. p. 91.

A resection of the shaft of the ulna, for disease, is ascribed by Velpeau to Scultetus, as early as 1675.

Partial excisions of these bones, on account of ununited fractures, were done by Fricke, in 1828, by Holscher, in 1830, and by Dr. Thomas Harris, U.S.N., in 1833. Similar operations were executed for compound and compound comminuted fracture, by Hublier, in 1829.

In 1853, Carnochan resected the entire ulna. Similar operations were performed by Mr. Jones, of Jersey, England, and by Dr. Muscroft, of Cincinnati. Butt, of Portsmouth, Virginia, removed the lower three-fourths of the ulna, in 1825, with an excellent result. Bell, of Edinburgh, and Hutchison, of New York, have excised the entire ulna. Raklitsky, Surgeon-in-Chief of the Morskoy Hospital, St. Petersburg, in 1837, removed the whole of the diaphysis of the radius. A similar operation was performed by Erichsen and by Carnochan, in 1854. Compton, of New Orleans, in 1853, excised portions of the radius and the ulna in its entirety. All of these cases recovered, it is said, with very useful hands.

A number of cases have been recorded in which the lower extremities of both the radius and the ulna have been removed on account of caries or morbid growths, leaving a useful hand. Among these may be mentioned those of Mr. Hancock and of Mr. Morris. In one case Erichsen removed the elbow-joint and the greater part of the radius at the same operation; and Williamson has excised the entire ulna along with the elbow-joint.

In a case of scrofulous disease, Professor Gross resected the upper half of the radius along with the external condyle of the humerus. I have made several partial excisions of these bones on account of compound fractures, caries, and morbid growths, and with the most satisfactory results.

Excision of the Bones of the Lower Extremity in their Continuity.

Excision of the Femur.—Partial excisions of the femur, in cases of compound comminuted fractures, and for pseudarthrosis, have occasionally been executed. Such operations are attended with great danger; and, except when done for compound comminuted fractures, they should be discarded from surgical practice. The removal of the shaft of the femur to any great extent, unless the union of the remaining ends could be secured, would render the limb both useless and an incumbrance.

EXCISION OF THE TROCHANTER MAJOR.—The trochanter major has, in a few instances, been excised when attacked by necrosis; and when the disease is limited to this portion of the bone—a very rare occurrence—the operation is entirely proper. The first excision of this kind was done by Tenon, as early as 1798; it has been repeated in England by Teale and Fergusson, in France by Velpeau, in Germany by Textor and Heyfelder, and in America by Parker.

OPERATION.—A director should be passed through one of the sinuses down to the diseased bone, when, by enlarging the opening, the necrosed portion may be extracted. If a more formal procedure is required, as when the fistulous orifices open upon the surfaces of the thigh, remote from the seat of the disease, an incision may be made parallel with and along the posterior border of the process, when, by clearing away the soft parts from the trochanter major, the necrosed portions can be reached by the bone forceps or gouge.

Before closing the wound the drainage-tube should be introduced, and its end brought out at the lower angle of the incision.

Excision of the Patella.—The patella, though requiring removal in cases of knee-joint excision, is rarely independently affected with disease.

The operation, however, has been practiced in a number of cases on account of caries, compound comminuted fracture, and also for shot injury.

Heyfelder's collection embraces 11 cases, with 9 recoveries and 2 deaths.

In 3 of these cases the excision was partial, and among the recoveries were 3 that demanded subsequent amputation. About 45 per cent. of these operations, therefore, failed.

Two cases of partial excision of this bone, following compound comminuted fracture, were done in the Pennsylvania Hospital, with the result of 1 recovery and 1 death.

RESULTS.—A case of the removal of a necrosed patella was reported by M. Thirion, of Namur, in 1829. In 1860, Dr. O. B. Knobe, of Missouri, excised the whole patella for necrosis after a fall, with the result of a good and useful limb.* Later, Mr. Wood, in a case recorded by Dr. Kelly,† removed the entire patella after it had become loosened. In 1876, Mr. Gay, at the Great Northern Hospital, excised a patella on account of necrosis, with a good result.‡ Heyfelder has discussed 11 cases of excision of the patella, 5 of which were for caries, 3 for fracture, and 3 for shot injury. In 8 of these the excision was complete. Of the entire number, 6 recovered without amputation, 3 recovered with amputation, and 2 died,—a death-rate of 18.18 per cent.

Excision of the Bones of the Leg.

Excision of the Tibia.—The objections which apply to the excision of the femur may with almost equal force be urged against a similar operation on the tibia.

The weight of the body is transmitted to the foot chiefly through this bone; and, should any considerable portion of its shaft be excised, independent of the fibula, the gap between the remaining portions of the bone would fail to be filled with new bone, thus rendering the limb incapable of supporting the superincumbent weight.

The subperiosteal excision of the tibia, though successful in a case reported by Mr. Heath,§ in which the entire removal of the tibia was followed by the reproduction of another bone, is an operation of great uncertainty. I have seen a partial operation of this kind done, but without any subsequent deposition of osseous matter.

Partial subperiosteal excision of the tibia will usually require the removal of a corresponding piece from the fibula. The experiments of Macewen, however, indicate that this may be avoided by filling in the gap with chips of living bone covered with periosteum, taken from another animal.

OPERATION.—This will be most conveniently performed by a longitudinal incision over the spine of the tibia, and, after carefully isolating the part of the bone to be excised from its periosteal and other connections, using the chain-saw to remove the affected part.

Dr. S. W. Gross has analyzed 172 cases of excision of the bones of the leg for gunshot injuries, 135 of which recovered and 35 died,—a death-rate of 20.34 per cent. In 19 of the 172 cases, portions of both the tibia and fibula were removed, with a result of 4 deaths,—a mortality of 21 per cent. Excision of a part of the tibia was done in 72 cases, with 15 deaths,—a death-rate of 20.8 per cent.,—while a similar operation on the fibula, in 81 cases, resulted in 16 deaths,—a death-rate of 19.7 per cent. The death-rate in all these cases (20.34 per cent.) exhibits a mortality considerably less than that following amputation of the leg.

In estimating the value of this excision, however, it is necessary to take into account more than the simple recovery. The inquiry should extend also to the subsequent condition of the limb. How many cases, for example, were followed by non-union, caries, and necrosis? and what number would be likely to demand amputation at some future period? If these points were fully ascertained, the operation of even partial excision of the tibia

* North American Medico-Chirurgical Review for 1860.

† Transactions of the Pathological Society of London, vol. xxii.

‡ Lancet, 1876, vol. ii. p. 322.

§ Transactions of the Clinical Society, London, 1877.

would have a very limited application. It would be confined chiefly to disabling deformities, and occasionally applied to a case of false joint.

Heyfelder gives 125 cases of excision of the tibia, performed on account of fractures, disease, pseudarthrosis, and deformities, 104 of which recovered and 21 died,—a death-rate of 16.8 per cent. Of the 104 recoveries, 97 were regarded as having useful limbs.

Excision of the Fibula.—The fibula, having a different functional position in the leg from that of the tibia, may be removed, in whole or in part, without entailing any serious disability on the limb. When possible, the malleolar process should not be disturbed, as its presence tends to prevent subsequent eversion of the foot. When the excision is partial, the ends of the bone may be morticed into the tibia, which will effect the same purpose.

The causes which may indicate the removal of the fibula, partial or entire, are necrosis, compound comminuted fracture, pseudarthrosis, and deformity.

OPERATION.—This is readily executed by making a longitudinal incision along the outer aspect of the bone, and, when feasible, shelling it out from its periosteum; after which the diseased part can be separated from the healthy part by the bone pliers.

In order to prevent the foot from being drawn outward by the action of the peroneal muscles, a splint must be placed upon the inner side of the leg; and, for some time after, it will be necessary for the patient to wear a shoe with steel supports attached, and extending above the knee. (Fig. 1104.)

The proposal to excise the fibula originated with Desault, and the operation was first performed by Percy. Seutin, Béclard, Malgaigne, and other surgeons have executed similar resections. Dr. Jackson, of Chicago, and Erichsen have each removed the entire fibula with success. These last two operations were done for disease,—the first in the case of an adult female, and the second in a child six years old.

Excision of the Tarsal Bones.—Any one of the tarsal bones may be the subject of disease or of injury for which excision will be required. Not all of these bones, however, are equally subject to disease. The astragalus, the os calcis, and the scaphoid are more frequently involved than the others. Their position and function necessarily expose them and their articulations to considerable concussion and strain.

EXCISION OF THE ASTRAGALUS.—This bone, participating in the ankle-articulation, may be attacked with caries as a sequence of a synovitis extending to its structure. Or it may be dislocated from its connection with the bones of the leg, either with or without an external wound, and become irreducible. In either condition—of disease or of accident—its excision may become necessary.

When disease extends to the astragalus from the other parts of the ankle-joint, it will not, generally, be necessary to make more than a partial excision of the bone, especially if an early operation is performed. For, in all probability, only a very limited portion of its structure (that immediately underlying the articular cartilage) will have become carious. But when the reverse is the case, and the inflammatory condition commences in the astragalus itself, it will be safer to extirpate the entire bone. Any portion which might be allowed to remain would, most probably, become diseased, and only serve to propagate the inflammation to the contiguous synovial membrane, and ultimately to the other bones with which it is associated.

FIG. 1104.



Apparatus to be worn after excision of the fibula.

The sinuses usually present in caries of the tarsal bones will, when explored with the probe, reveal the affected piece.

OPERATION.—A semilunar incision should be made across the outer and anterior surface of the ankle, taking care to avoid cutting the extensor tendons of the foot or the dorsalis pedis artery. The former being carefully raised and held aside, the anterior extremity of the astragalus will be exposed.

With a strong pair of cutting pliers the bone should be divided through its neck, and, after detaching the head from its connection with the scaphoid, it may be drawn away by the lion forceps. The removal of this piece gives room for further operations.

The body of the bone must now be seized with the forceps, and while being twisted from its bed its ligamentous connections should be divided by means of a strong, blunt-pointed knife, observing to keep the latter in close contact with the piece to be removed, in order to avoid inflicting any injury on either the posterior tibial or the plantar artery.

If the substance of the bone is much involved, it will crumble down under the grasp of the forceps, rendering the operation both tedious and difficult. In such cases the gouge will greatly facilitate its removal.

After the diseased piece has been extracted, the articulating extremities of the tibia and fibula must be carefully examined, to be assured of their soundness. If found to participate in the disease, it will be necessary (provided the affected ends cannot be attacked from the wound already existing) to prolong the external incision upward behind the external malleolus, to dissect out the peroneal tendons from their grooves in the fibula, and to cut away the inferior extremity of the fibula. If the foot be now strongly abducted, the internal malleolus may be divided with the pliers, and be very carefully dissected away from its ligamentous connections.

Should it be necessary to excise any more of the bones of the leg, it can be done by the gouge, or by causing them to protrude through the external wounds, using for this purpose the chain-saw.

DRESSING.—After removing the astragalus and thoroughly cleansing the wounds, the bones of the leg should be brought in contact with the upper surface of the os calcis; a drainage-tube should be introduced, and the edges of the incision closed by the interrupted suture and protected by a dressing of carbolated oil.

A splint similar to that directed for excision of the ankle will answer equally well for the support of the foot and leg during the subsequent treatment.

The operation for the removal of the astragalus in cases of dislocation of the bone in which the latter has become carious, or in which, by its abnormal position, it induces ulceration of the overlying soft parts, is a comparatively easy task, requiring for its accomplishment little more than exposure and traction by the bone forceps.

RESULTS.—Mr. Hancock has given 109 cases in which complete excision of the astragalus was performed. Of this number, 64 were treated for compound dislocation, 20 for simple dislocation, 11 for disease (of which 10 were for caries), and 4 for compound fracture, while for 10 the causes were not stated. Of the 64 treated for dislocation, 5 were complicated with fracture, and 4 with compound fracture. The results attending these operations were as follows: of the 64 excisions for *compound dislocation*, 50 recovered with good and useful limbs; 1 underwent secondary amputation of the leg, and recovered; 11 died, of whom 1 had undergone secondary amputation; and of 2 the results are not given. Of the 4 operated on for *compound fracture*, 3 recovered with good and useful limbs, and 1 died. Of the 20 treated for *simple dislocation*, in 4 (of whom 1 died) the bone was allowed to remain for a month; in 1 the bone remained for nineteen weeks; in 7 (2 of whom died) the bone was removed immediately; in 2 the bone was removed with a secondary caries, but at what period is not stated; in 6 the period of re-

removal was not given. Of these 20, 14 recovered with good and useful limbs, 3 died, and in 3 the results are missing. Of the 10 upon whom the excision was done for *disease* (caries), 6 recovered with good and useful limbs; 1 underwent secondary amputation two years afterwards, and recovered; 1 died; in 2 the result was not stated. So that of 109 cases, 76 recovered with good and useful limbs; 16 died (a death-rate of 14.6 per cent.), including 1 of two cases which submitted to secondary amputation; and in the rest the result was doubtful.*

The cases collected by Poisson number 144, of which 26 proved fatal,—a death-rate of 18 per cent. Mr. Gant records 14 cases of *complete excision* of the astragalus for disease (13 of which were for caries). Of these 14, 9 recovered or did well, 2 underwent secondary amputation and recovered, in 2 the result was not reported, and 1 died.† The proportion of success in these cases was, according to these data, about 60 per cent.

The removal of the astragalus has been performed a number of times successfully in Philadelphia, the operators being Packard, Morton, Brinton, and the author. Dr. Kane removed both bones in a patient at the same time, and with a good result. Mr. Holmes, in his work on "The Surgical Treatment of Children's Diseases" (p. 491), has discussed excision of the astragalus, scaphoid, and tarsus, at some length.

HISTORY.—The removal of the astragalus was first performed by a surgeon of Duisburg, in 1582, as recorded by Fabricius Hildanus, and again in 1646, by Severin. This last case, however, was a partial excision. In England, in 1792, the first incomplete resection of this bone was made by a surgeon named Ramsay. Cases of complete excision of the astragalus have been recorded in England by Brusk, in 1850, by Erichsen, Statham, and Holmes.

Excision of the Os Calcis.—The excision of the calcaneum may be required on account of caries, necrosis, or comminuted fractures. The operation is one of much less difficulty than that of excising the astragalus. This bone is more frequently attacked by caries than any other portion of the tarsus,—a fact due, no doubt, to its functional position, by which it is necessarily very much exposed to contusions. The extent of cancellated tissue in its structure may also predispose it to inflammatory disease. In many instances of disease it will be necessary to excise portions of this bone, and this can be best accomplished by the use of the gouge.

OPERATION.—The incision should be planned in such a manner that the cicatrices following the healing process shall not be in a position to be subjected to pressure. Hence the operation of Mr. Erichsen possesses advantages which should entitle it to general acceptance. By this method, the patient having been placed on his breast, an incision is commenced about three-quarters of an inch behind the tuberosity of the metatarsal bone of the little toe, and carried back around the heel, and along the inner side of the foot, terminating opposite the point of beginning.

It is not necessary, however, to carry the incision as far forward on the inner as on the outer side of the foot; it may stop three-quarters of an inch short of that point. Care must also be observed not to divide the tendon of the peroneus longus muscle as it passes through its groove in the cuboid bone, half an inch behind the metatarsal bone of the little toe.

The flap thus circumscribed by the horseshoe-shaped incision is next to be raised cleanly from the bone and turned forward over the anterior part of the sole of the foot.

A vertical incision is next to be made over the tendo Achillis, terminating in the horizontal one; the integument and the subcutaneous tissue are to be reflected to either side, and the tendon shaved off from its insertion upon the bone.

The knife is now made to enter posteriorly, and is carried along the upper

* *Lancet*, August 5, 1871, p. 185.

† *New Sydenham Society's Biennial Retrospect for 1865-66*, p. 281.

surface of the calcaneum until the interosseous ligament, connecting the bone with the astragalus, is reached and divided. (Fig. 1105.)

When this is effected, the os calcis can be drawn backward and separated from its lateral attachments by keeping the edge of the knife applied closely to its surface. If this is carefully executed, the long peroneal tendon need not be damaged.

FIG. 1105.



The os calcis exposed by the plantar flap.

The last step of the excision consists in severing the calcaneo-cuboid articulation, after which the bone can be removed in its entirety.

Holmes advises that the incision should be made on a level with the upper surface of the os calcis, commencing at the inner edge of the tendo Achillis, and, after extending around the heel, should be prolonged a short distance in front of the calcaneo-cuboid articulation, dividing in its course the tendo Achillis. From the anterior termination of the first incision a second is carried across the sole of the foot, and ends at the outer border of the grooved internal surface of the os calcis. After reflecting the flaps, the os calcis should be disarticulated from the cuboid, and afterwards from its connection with the astragalus, the surgeon using the lion forceps to twist the diseased bone from its bed and thus to aid in its detachment.

Teale and Page prefer an incision similar to that employed by Syme in his amputation at the tibio-tarsal joint. I can see no advantage possessed by these operations over that practiced by Erichsen, save in the possibility of avoiding the chief trunks of the plantar vessels, by the plan proposed by Mr. Holmes.

The dressing will be the same as that employed in excisions of the ankle-joint.

Southain and Laird, of Manchester, adopt a single incision, beginning as that of Holmes, and terminating over the peroneal tubercle of the calcaneum. I have myself, by a single incision, very satisfactorily exposed the bone in cases of incomplete excision.

Ollier describes a *subperiosteal excision* of the os calcis, which is performed by making one incision from the inner side of the tendo Achillis around the heel to the cuboid bone, and a second incision vertically along the side of the tendo Achillis into the first; after which the periosteum is raised by an elevator, including the tendons. Holmes has performed this operation once. He does not speak very favorably as to the result, but thinks the operation worth a trial. Nor are its claims to professional confidence supported by statistics. On *subperiosteal* resection of the calcaneum much has been written in the *Gazette Hebdomadaire* for 1876, pp. 497, 507, and 527.

RESULTS.—Dr. Burrall, of New York, summarizes 48 cases of excision of the entire os calcis, with 33 good results.* Of the whole number, 38 were done for caries, 1 for caries and necrosis, and 1 for necrosis, with 7 subsequent amputations. Of 21 of these cases, collected by this writer (14 of which were strumous and 3 healthy), 17 were successful, 1 died, and 1 underwent secondary amputation, the proportion of success amounting to about 80 per cent.

In 12 similar cases, reported by Mr. Greenhow,† of England, 10 were successful; in 1 of these, however, the patient subsequently died of phthisis, and in 1 the foot, when last seen, was unfit for use. These 12 cases are included in Dr. Burrall's compilation of 48.

* Bellevue and Charity Hospital Reports for 1870.

† British and Foreign Medico-Chirurgical Review, July, 1853.

Mr. Hancock has collected 38 cases of partial excision of the os calcis on account of disease; 23 of this number recovered, 1 died, and the results of the remaining 15 were not ascertained. Among the 23 recoveries, 13 required secondary excision, and 2 amputation. The same author has analyzed 34 cases of total excision of the calcaneum, 29 of which were successful, 1 died, and in 4 the termination was not ascertained.

M. Rigaud, of France, states that he has executed 11 entire resections of the os calcis, in cases where the bone was entirely diseased, with 10 good results.*

Professor Polaillon gives 55 carefully-digested cases of extirpation of the calcaneum for caries and necrosis. This author estimates that of this number there were 16 failures (6 failures to restore usefulness to the foot, 7 cases in which amputation became necessary, and 3 deaths from the operation), with 39 favorable results.† The percentage of failures, therefore, is 29.09. The number of failures in cases between the ages of twenty and thirty years was very large, viz., as 7 to 9. The most propitious ages for the operation were under ten and over thirty years. Only one case depended upon syphilis. This French investigator remarks, "Operators always take less pains to make known their failures than their successes, especially in a mooted operation so little practiced as this," contending also that as this operation is performed as a substitute for amputation, and with the object of securing a good and useful limb, in cases where less than this is attained the excision should be set down as "*bad*."

The operation, so far as my own experience and observation extend, has been followed by the most satisfactory results in all cases in which the disease was limited to the os calcis.

M. Vincent, a pupil of Ollier, in a work on this subject,‡ analyzes 23 operations for the entire removal of the calcaneum. Those executed by the subperiosteal method alone gave reproductions of the calcaneum and procured the finest results as regards the form and function of the foot. The fatal cases, however, M. Vincent finds were more numerous when the subperiosteal method was employed than when the old was practiced, particularly in patients over twenty-five years of age.

Excision of the Calcaneum and Astragalus.—As disease of the tarsal bones very frequently commences in the articulation between the os calcis and the astragalus, it occasionally happens that both become simultaneously involved, and may demand removal.

OPERATION.—When it is proposed to excise both the calcaneum and the astragalus, an incision should first be made similar in all respects to that directed by Erichsen for the removal of the former bone, after which a second is required, running vertically along the side of the tendo Achillis and joining the first incision.

The tendo Achillis is next divided. Afterwards the three flaps are to be dissected up and reflected,—the plantar one forward, and the two others upward and outward.

The external malleolus being exposed, the lateral ligament is next to be divided, and the lower end of the fibula cut through with the bone pliers and dissected out. By strongly abducting the foot, the internal lateral ligament may be divided, inside of the joint, with a blunt-pointed bistoury. In doing this, great care must be exercised that the posterior tibial artery be not wounded.

From the same side, the internal malleolus can be severed with the bone pliers; after this the bones can be separated from their connections with the scaphoid and cuboid and be removed.

This operation was performed by Mr. Wakely,§ in 1847, at the Royal Free Hospital. It has also been done by Dr. Morton (in a case admitted into the

* Gazette Hebdomadaire, No. 33, 1875.

† Archives Générales de Médecine for September and October, 1869.

‡ Vincent, De l'Ablation du Calcaneum, Paris, 1876.

§ Lancet, July, 1848.

Pennsylvania Hospital for injury), by Dr. Whitehill, and by Bradford, of Kentucky.

HISTORY.—The first partial excision of the calcaneum was probably executed by Formius, in 1669, for the extraction of a ball imbedded in the bone. In 1814, Monteggia made the first total excision of the calcaneum; and in 1837 a similar operation was performed by M. Robert, of Prague. In 1848, Mr. Hancock removed the calcaneum, which was the first operation of the kind reported in England; and this was repeated by Mr. Greenhow, of Newcastle, England. Since 1848 it has been done many times by different surgeons.

Excision of the Cuboid, Scaphoid, and Cuneiform Bones.—Excisions of these bones, individually, may be required on account of disease or injury. The operation can be easily accomplished by exposing the affected piece from the dorsal surface of the foot, taking care to push aside any tendon that may be in the course of the incision, and then employing the gouge to remove the bone.

The operation will be preferable to the amputation of Chopart, and may be done with a favorable result. If it should fail, the probable success of a future amputation is not in any way diminished.

All of these bones have been removed, first by Professor Bigelow, of Boston, in 1855, and afterwards by Mr. S. Key, leaving the astragalus and calcaneum posteriorly, and the metatarso-phalangeal bones anteriorly, with a highly favorable result.

RESULTS.—Conner has collected 35 cases of excision of portions of the tarsus, 25 of which were successful, 5 proved unsuccessful, and 5 died,—a death-rate of 14.2 per cent.

When several of the tarsal bones in front of the os calcis and astragalus are involved in disease or injury, a Chopart or Pirogoff amputation will be preferable to excision.

Excision of the Metatarsal Bones.—The metatarsal bones may be excised either partially or entirely.

They are best exposed by an incision made over their dorsal surface, the tendons being raised and held out of the way.

By the use of the pliers the bone can be divided, and afterwards dissected out with a blunt-pointed bistoury, so as not to endanger the vessels beneath.

Partial resection of the fourth metatarsal bone for caries was performed by the elder Moreau in the year 1788 (he removed the base of the bone); by Textor, in 1822, a similar operation was done for caries of the fifth metatarsal bone.

Mr. Butcher has described a case of excision of the metatarsal bone of the great toe,* with recovery and perfect use of the foot.

Excision of the Toes.—The phalanges which admit of excision are the metatarsal extremity of the proximal phalanx of the great toe, and the ungual phalanges.

The removal of an intermediary phalanx would render the toe utterly useless, and should not be practiced.

RESULTS.—In 1863, Mr. Burford Norman, of Southsea, England, in a case of necrosis involving the distal phalanx of the great toe of a lad, instead of amputating the toe at the joint behind the nail, dissected the integuments, nail included, away from the phalanx, and cut the latter through by the forceps, behind the seat of exostosis.† The patient recovered with a good toe and a good nail. A case of resection of the metatarso-phalangeal joint of the great toe was reported by Mr. Butcher in the Dublin Journal for 1859, done for caries in a girl aged eighteen, with success. Mr. Hancock has reported 5 other successful excisions of this joint.‡

* Butcher's Operative and Conservative Surgery, p. 355.

† Hancock on the Operative Surgery of the Foot and Ankle-Joint, p. 451, London, 1873.

‡ Hancock's Anatomy and Surgery of the Human Foot, pp. 448, 449.

CHAPTER XVII.

CONSIDERATION OF SUBJECTS CONNECTED WITH MINOR SURGERY.—ON THE USE OF THE KNIFE.—VENESECTION.

Positions of the Knife.—It is not only necessary that the surgeon should possess a steady hand to direct the movements of the knife, but it is also desirable that he should cultivate ease, grace, and elegance in executing these movements.

The use of the scalpel or bistoury has been reduced to certain arbitrary positions. The French make six of these positions. In enumerating them I shall employ a different (and more natural) order from that usually adopted.

FIRST POSITION.—In this position, the knife is held like a writing-pen, being grasped between the thumb and the index and middle fingers, just where the blade and the handle of the instrument join, while the hand is supported on the outer side of the little and the ring finger. This is the most common manner of holding the instrument; and in making incisions the movements are chiefly executed by the thumb and fingers alone. (Fig. 1106.)

FIG. 1106.



First position.

FIG. 1107.



Second position.

SECOND POSITION.—The second position is nearly the same as the first,—the edge being *reversed*, that is, directed *from*, not *towards*, the operator. (Fig. 1107.)

THIRD POSITION.—In the third position, the knife is held much after the manner of a carving-knife. That is, the point where the handle and the blade of the knife join is embraced between the thumb and the middle finger, the handle being concealed from view in the palm of the hand, and surrounded by the ring and the little finger, while the index finger is extended, and rests on the back of the blade of the instrument. (Fig. 1108.) The knife is much employed in this position in cutting down upon large growths, where free, bold incisions are allowable.

FIG. 1108.



Third position.

The amputating knife, as used in the formation of musculo-cutaneous flaps by transfexion, is held in the same manner, the blade being on its flat.

FOURTH POSITION.—The knife is held in a manner similar to the third, only with the edge reversed and the index finger less extended. The position is

a very common one when dividing layers of tissue on the director,—the knife being pushed from, instead of towards, the operator. (Fig. 1109.)

FIG. 1109.



Fourth position.

FIFTH POSITION.—In the fifth position, the knife is held between the thumb and the index and middle fingers, with its edge looking upward, and its point directed towards the operator,—a position much used when dividing fasciæ on the director. (Fig. 1110.)

SIXTH POSITION.—The knife is held like a violin-bow,—between the thumb and the fingers,—all parts of the scalpel being exposed. This position is one which answers well for delicate touches, as in cutting small shreds of fascia. (Fig. 1111.)

The knife, to be used with the greatest precision and safety, should possess a keen edge, so that the tissues can be penetrated with the least possible

FIG. 1110.



Fifth position.

FIG. 1111.



Sixth position.

pressure. If the operator is obliged to apply much force in order to divide the soft parts, the instrument may unexpectedly go farther than was designed, and, in regions beset with important vessels or nerves, might inflict irreparable evil.

The handle of a scalpel or bistoury should be of good size, and entirely smooth. The file-like or roughened surface so often formed by the cutler is objectionable on the grounds of cleanliness and safety. It is not improbable that disease may be communicated from infectious matters which lie concealed in these little grooves. For this reason the greatest care should be observed thoroughly to cleanse and disinfect all instruments after using them. This is best done by immersing them in a carbolic acid bath after every operation, and, before restoring them to their place or case, having each article smeared over lightly with cosmoline,—a precaution which effectually prevents oxidation or rust.

MANNER OF DIVIDING PARTS.—The edge of a knife, however sharp, must operate as a saw, and consequently will drag before it the skin, which is, usually, very movable, and will thus change the relation of the integument to the subjacent parts and render the incision less precise than it should be. To prevent this, the integument should be fixed or slightly stretched by the thumb and fingers of the surgeon, placed on each side of the point where the cut is to begin. (Fig. 1112.)

In order that the incision shall have the same depth from its commencement to its termination, the point of the scalpel or bistoury, when held in

the first position, should be entered nearly perpendicularly to the surface of the skin, then brought to an angle of about forty-five degrees while the cut

FIG. 1112.



Skin fixed while an incision is being made.

is being prolonged towards the person of the operator, and be finally brought again to the perpendicular.

The division of the deeper tissue planes should be made parallel with that in the skin, and in most instances of the same length. It is a good rule, especially in all deep operations, to make the external incision lengthy rather than short. It not only gives a more satisfactory view of the parts, but in no way interferes with their rapid repair. As the skin is the most sensitive tissue, its division, especially when the patient is not under the influence of an anæsthetic, should be made by a rapid stroke or sweep of the knife, without removing the blade from the part until it has traversed the entire length of the contemplated cut. Short cuts are to be avoided, except when the bistoury is approaching a dangerous locality.

Incisions may be made from without inward, or from within outward. When the latter plan is pursued, a fold of the integument is raised between the thumb and fingers, and a sharp-pointed bistoury pushed through its base and made to cut out. This method is sometimes practiced in dividing the layers over a strangulated hernia. The division will be made with greater precision and facility if the fold of integument is held by both the surgeon and an assistant, their fingers being a short distance apart.

In all operations in important surgical regions, after the division of the skin the deeper layers should be raised upon a director, as a prudential measure, before being incised; and each layer of tissue should be carefully inspected before its division, so as to make sure that no important vessel, nerve, or other structure shall be unwittingly severed.

Whenever tissues can be separated without cutting, the handle of the scalpel, the director, or the fingers of the surgeon should be used instead of the knife.

In planning incisions, attention must be given to direction and locality. When made in the direction of, or parallel to, the course of muscular fibres which may lie beneath, the subsequent approximation and retention of the edges of the wound will be favored. This is a very important consideration in operations done on the face. If not observed, the facial expression may be seriously altered. As to the locality of incisions, when feasible, it is desirable that they should be so made that the resulting cicatrix will be in shade, or out of view, as, for example, in removing the inferior maxillary bone, immediately beneath the base of the jaw; or, in excisions of the metacarpal bone of the thumb, along the line of junction between the dorsal and palmar aspects of the skin of the hand.

In operations requiring the formation of flaps, as in the removal of large morbid growths, or in amputations, while it is necessary that there shall be an ample extent of tissue preserved for closing the wound or covering the stump without the least tension of the flaps, it is also proper that there shall not be any great redundancy, as it tends rather to defeat than to favor rapid

healing, by allowing pockets to form beneath for the reception of purulent and other inflammatory formations. The great elasticity of the skin, and its consequent retraction, must be duly considered in estimating the amount of flap necessary in a given operation.

FORM OF INCISIONS.—The form of an incision must be determined by the peculiarities and necessities of the operation. Under the head of *simple incisions* are included those which consist of a single line, and these may be linear or straight (Fig. 1113); curvilinear, like the italic letter *S* (Fig. 1114); elliptical (Fig. 1115); or semilunar (Fig. 1116). These forms of the simple

FIG. 1113.

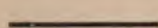


FIG. 1114.



FIG. 1115.



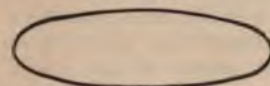
FIG. 1116.



incision are adapted to the removal of tumors in which it is not necessary to take away any redundant integument. They are also well suited for the exposure of blood-vessels, as in ligation of the arteries, for operations for strangulated hernia, and for uncovering the skull in trephining.

The *compound incisions* are formed by two or more lines. Thus, there is

FIG. 1117.



the ellipse (Fig. 1117), in which two or more curvilinear cuts are made to join at the extremities, and which is adopted in all operations requiring the removal of an excess of skin, as in excision of the mammary gland. There are also the inverted Λ , the T, the V, the L, the \sqcup , and the H. In order to hold the flaps in a proper position during their

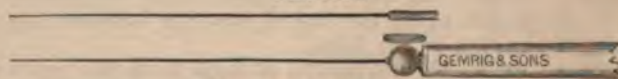
dissection, the forceps or the fingers of the operator will be required, the latter being always more satisfactory when the flaps which are being raised are massive.

Hæmorrhage.—Hæmorrhage may often be prevented by an assistant making pressure with his finger on the main trunk of an artery, the branches of which come within the sphere of operation. In this way, by compressing the facial arteries where they pass over the inferior maxillary bone, in front of the masseter muscles, plastic operations on the face, or those for hare-lip, may be executed in an almost bloodless manner. In all instances where an artery or a large vein is wounded without being entirely severed, the vessel should be cut completely across, and subsequently tied.

Punctures are made with the sharp-pointed bistoury, with a thumb lancet, or with needles. In using either the bistoury or the lancet for this purpose, the instrument is held in the first position, with the point at nearly a right angle with the surface to be divided. If it is desired to regulate very nicely the depth of penetration, the fingers can grasp the blade of the lancet or the bistoury at the required distance from the extremity, and thus prevent the instrument from going to a greater depth than that desired. The opening of an abscess, or the operation of venesection, will afford good examples of this plan of dividing the soft parts.

When the puncture is made with a long, delicate needle, it constitutes *acupuncture*. The instruments required for its execution are long, very slender, and properly-tempered needles, which can be fitted into a handle,

FIG. 1118.



Acupuncture needle and handle.

the latter being detached as soon as the puncture is completed (Fig. 1118). This operation, quite common among certain Asiatics, as the Chinese and

Japanese, is frequently employed in this country, and in certain chronic affections of the nerves, as sciatica, is sometimes productive of much good. The needles often require a little rotatory motion to insure their ready entrance into the tissues.

With a view to establish temporary counter-irritation in chronic cases of disease, an instrument capable of making numerous shallow punctures, in a manner almost painless, is sometimes employed. (Fig. 1119.) In

using it the needles are drawn some distance into the hollow metallic shell by means of a stem and spring, and then released, when they are driven in an instant a short distance into the skin. The counter-irritation can be much increased by dipping the points of the needles, before using them, into a mixture consisting of equal parts of croton oil and olive oil. The punctures are followed, in the course of twenty-four hours, by numerous vesicles.

FIG. 1119.



Instrument for making multipunctures.

Venesection.

The operation of venesection requires an accurate anatomical knowledge. During the sanguinary period in the history of the profession it was no uncommon thing for the blacksmith of a neighborhood to act as phlebotomist. Consequently aneurismal varix and varicose aneurism were not unfrequently encountered as a result of the ignorance of the operators, who did not understand the relations of the brachial artery at the bend of the arm. Phlebitis, lymphangitis, and neuralgia were also induced,—the first two by the contusion or laceration of the vein or lymphatics from dull instruments, or perhaps by the use of foul lancets; and the last, by the wounding of branches of the internal cutaneous nerve. From these accidents many persons lost the use of their arms, and not a few perished.

Blood may be abstracted from any of the superficial veins; but the bend of the arm, or the inner side of the leg, above the ankle, is the region generally selected for the operation.

SUPERFICIAL SURGICAL ANATOMY AT THE BEND OF THE ARM.—The veins on the anterior and the posterior part of the radial side of the forearm, a short distance below the elbow, join to form a single trunk,—the radial vein,—which constitutes one of the chief tributaries of the cephalic. The venous branches on the two aspects of the ulnar side of the forearm, by their confluence, form one of the principal roots of the basilic vein; whilst the median vein, occupying the middle of the forearm, divides into two trunks, the one passing upward and outward to join the cephalic,—the *median cephalic*,—and the other upward and inward to enter the basilic,—the *median basilic vein*. Underneath the last-named vessel lies the brachial artery, only separated from it by the aponeurosis—*bicipital*—derived from the tendon of the biceps muscle. Over the surface of the same vein pass numerous nerve-filaments, branches of the internal cutaneous. (Fig. 1120.) The median basilic vein,

FIG. 1120.



Arrangement of veins at the bend of the arm.

which is usually the largest and most prominent, would naturally be selected

for the abstraction of blood; and yet, as it lies over the brachial artery and is covered by several nerve-twigs, it is certainly the most dangerous location for the operation. For this reason the median cephalic is to be preferred, especially by persons who are not very familiar with the use of the lancet.

The saphena interna vein is formed by branches arising over the inner surface of the dorsum of the foot and of the ankle; the vessel is accompanied by the long saphenous nerve, which usually lies along the posterior face of the vein.

Instruments.—Two instruments are employed for the purpose of opening a vein in the operation under consideration, viz., the *thumb lancet* (Fig. 1121) and the *spring lancet* (Fig. 1122). The latter is to be preferred, not only on

FIG. 1121.



Thumb lancet.

FIG. 1122.



Spring lancet.

account of requiring less skill in its use, but from the painless manner in which the vein can be divided by it.

In the hands of a skillful operator, however, provided the blade be sharp, it is a matter of very little importance which instrument is employed.

OPERATION AT THE BEND OF THE ARM.—The arm should be carried off at a right angle with the body, the hand at the same time grasping a broomstick or a cane. A strip of roller bandage or a ribbon, one inch wide, is next carried twice around the arm, about three inches above the elbow, and secured by a bow-knot. This fillet must be made sufficiently tight to arrest the circulation through the superficial veins and cause them to swell up, and yet not so tight as to interrupt the circulation through the brachial artery. The veins, should they not be made sufficiently prominent by the simple constriction of the arm by the band, may be rendered more so by the patient's alternately tightening and relaxing his hold upon the cane, while the operator rubs the forearm for a few moments from below upward. The same movements will promote the flow of blood after the vein has been opened.

The surgeon now locates the position of the brachial or any other artery which may be present. If using the thumb lancet, he grasps the blade of the instrument between the thumb and the index finger, and, while the vein is fixed by a finger of the other hand, placed below the seat of operation, a puncture and incision is made into the vessel in a direction oblique to its longitudinal axis. If the division of the vein and that of the integument accurately correspond, and are sufficiently free, a stream of blood will issue with considerable force, and should be received into a vessel provided for that purpose. When the spring lancet is used, the fleam must also be placed obliquely over the vein, and pressed somewhat against the skin before being sprung, otherwise it will fail to enter the vessel.

The advantage of the oblique incision is twofold. It produces a gaping orifice favoring the flow of blood, and, in the event of the instrument's coming in contact with a nerve-filament,—a very likely occurrence,—the branch will

be severed completely across, causing less inconvenience or evil consequence than would result from a simple puncture.

Should the patient become pale and sick at the stomach, with indistinct vision, and should profuse perspiration appear on the forehead and face, the flow must be stopped. These symptoms may occur either from the erect position occupied by the patient, or from a mental impression, even before two ounces of blood have been abstracted; and, when such is the case, the recumbent posture must be assumed, with the head low.

When the requisite amount of blood has been drawn, the fillet should be untied and removed from the arm, and a finger or the thumb placed upon the vein immediately below the wound, in order to prevent any oozing while the surface is being wiped clean with a napkin. The opening is next closed by placing over it a compress of old linen, and securing the same with the fillet used to compress the arm, applied in the form of the figure-of-eight. The wound usually heals in two or three days, when the dressing may be thrown aside.

VENESECTON ON THE LEG.—When it is desired to abstract blood from the leg, the surgeon selects one of the chief branches of the internal saphena, on the inner aspect of the leg, about four inches above the ankle. A bandage is first placed around the junction of the middle and the lower third of the leg, in order to interrupt the return of the blood through the surface veins of the extremity, after which the foot may be placed in a vessel of warm water, the latter serving to increase the fullness of the veins, by inviting a greater flow to the part. When this is done, the opening is made by either the thumb or spring lancet, in the same manner as that practiced at the bend of the arm; and the closure of the wound is also effected in the same way.

When, after venesection, the parts around the wound become inflamed, tender, and swollen, the affected surface should be covered with a lotion of lead-water and laudanum, the arm kept in a slightly-flexed position, and rest rigidly enforced.

CHAPTER XVIII.

GENERAL CONSIDERATIONS WITH REGARD TO OPERATIONS.

THE PREPARATION OF A PATIENT to undergo an operation is the first duty of the surgeon. Indifference on this point, except in cases of pressing emergency, argues great rashness and disregard of human life on the part of an operator. No operation, however simple, is entirely devoid of danger. I have seen a patient perish from the introduction of a sound into the bladder; and there are numerous similar cases recorded. Death occasionally follows the removal of a sebaceous cyst from the scalp, or the amputation of a finger, operations generally deemed of the most trivial nature.

The first question which a surgeon should decide when called to consider a case of surgical disease supposed to demand operative interference, is the one of *necessity*. In general, it may be said that no operation is proper when the cure can be accomplished in any other way. If the disease is one which does not threaten either the comfort, the usefulness, or the life of the individual, the performance of any operation had best be declined. We are never justifiable in subjecting patients to unnecessary risks. Even in instances where, under ordinary circumstances, an operation would be proper, if, on a careful examination, the chances prove to be largely against recovery, the knife should be withheld. Again, when the probabilities are that an operation will not leave the patient in a better condition than before its execution, it will be wise to abstain from any interference.

No operation should be undertaken against the judgment of the surgeon on account of the importunity of the patient. Responsibility cannot be divided or transferred. A patient who is to be subjected to a grave operation is entitled to have a reasonable assurance from his surgeon that a successful issue may be anticipated. Of course it is not designed to convey the impression that the surgeon is expected to guarantee the lives of his patients. Many things which no human foresight could have prevented may occur to cause a case to miscarry. All that is claimed is that an operation should only be undertaken under conditions which usually insure success. To reach such knowledge it is necessary to inquire into the *habits* of a patient. Persons who lead indolent lives, or are addicted to the excessive use of alcoholic drinks, or to the indulgences of the table, are bad subjects for the knife. They cannot endure the shock of a surgical operation, and are often, after such, attacked by delirium tremens. Their wounds tend to suppuration, or to erysipelatous inflammation, and consequently either slough or heal very slowly.

Age.—Neither the very young nor the very old tolerate well severe operations. Children cannot safely endure any great loss of blood; and the same is true of aged persons. In the former class, it is desirable to postpone operations of any magnitude as long as possible, or as long as may be consistent with the health of the patient; and in those far advanced in years, where the disease will not, from its nature, tend to shorten life, or where the use of the knife will not prevent the reproduction of the disease, it is well to abstain from any operation. Amputations and lithotomy are rarely successful in persons who are over seventy-five years of age.

Pregnancy contra-indicates the use of the knife, save in cases where, from the nature of the affection, delay of surgical interference jeopardizes the life of the patient.

Menstruation is a condition likewise unfavorable to operations. The system is usually more or less perturbed during its presence, and the *morale* of the patient also impaired. The most desirable period to operate in females during the period of life in which this function is present is four or five days after its subsidence, or ten or twelve days antecedent to its appearance.

Internal organs.—A careful inquiry should be instituted into the condition of the internal organs before consenting to undertake any severe operation. Under this head, the state of the *renal* organs occupies a most conspicuous position. Nothing is so essential to the success of a surgical operation as sound kidneys. Should these organs be diseased, the risks attending the use of the knife are increased a hundredfold.

Organic disease of the *liver* is also a bar to operations, though in a much less degree than structural alteration of the kidneys. Disease of the *lungs* is also unfavorable to the success of an operation, especially one in which the work of repair is likely to be tardy. Not only is pulmonary tuberculosis inimical to the reconstruction of wounds, but its own destructive processes are intensified by the additional demand made upon the resources of the general system after an operation.

The condition of the *heart* must not be overlooked in making the surgical inventory of the organs. A fatty state of this organ, with or without valvular complications, tells against the success of a severe operation. And this should always be suspected when a patient's circulation or respiration becomes disturbed after a little active exertion. Persons so affected do not react well, and may perish from collapse. Slight valvular disease, though an unfavorable lesion, is not a bar to operations of necessity.

Idiosyncrasies and peculiarities of constitution form also proper subjects for inquiry. There are some persons who find that even a scratch on their persons will obstinately refuse to heal for a long time, some in whom the slightest wounds will provoke an attack of erysipelas, and others again who possess a peculiarity of the vascular system making it difficult to control the flow of blood which follows a wound. I remember a number of cases in which indifference to this condition came very near causing the loss of life. In one instance the patient actually perished before the surgeon's eyes, although the operation was a very trifling one, viz., the excision of a cyst the size of a hickory-nut, which was situated on the side of the thorax.

Women possessing a very excitable nervous system, with hysterical tendencies, are not favorable subjects for an operation, especially one of severity; and, when added to this organization there exists a feeble heart, the dangers are greatly increased. Such persons are incapable of withstanding the effects of shock, and often sink under the consequent exhaustion. Mere nervous excitement, if not associated with despondency, does not contra-indicate an operation. Persons of such a temperament, though they suffer much, both in body and in mind, soon recover their usual flow of spirits, which, acting like a cordial, serves to hasten recovery.

Obesity is highly unfavorable to the success of a surgical operation. The wounds of persons loaded with fat suppurate freely, heal slowly, and are often attacked with erysipelas, and sometimes with sloughing.

Residence.—Persons living in the country generally endure operations better than residents of large towns or populous cities. The explanation of this fact must be sought for in the more simple and less artificial mode of living among country people.

Inflamed state of parts, and constitutional infection.—To operate on a part in a state of acute inflammation is a most dangerous procedure. A prudent surgeon would not even amputate a tonsil which was actively inflamed, or ligate a mass of hemorrhoids in a similar condition. To excise a joint in a state of acute inflammation would be homicide. The presence of any accidental indisposition is a bar to operations. The occurrence of a severe headache, or a chill, a little febrile excitement, or an inflamed gum in a child, are all sufficient reasons for withholding the knife.

In cases of malignant disease, where the diathesis is strongly marked, or where there are at the same time morbid growths of this nature in different organs or parts of the body, operations, save those of necessity, *e.g.*, tying a bleeding artery, are inadmissible. The same is true when the system is suffering from pyæmia or erysipelas.

Chronic disease, in many instances, enhances the probability of success of a surgical operation. Thus, we find that articulations which have long been the seat of caries or necrosis admit of being excised with singular impunity. The system is tolerant of the knife from having become adjusted to the local irritation. The tendency, however, of protracted suppuration to work structural alteration in the kidneys and the lungs should always induce the surgeon to examine into the condition of these before deciding on the course of treatment.

Epidemic influences.—During the prevalence of epidemic diseases, such as erysipelas or diphtheria, operations should be declined, except those which do not admit of delay. Inattention to this precaution has often been followed by loss of life, the wounds becoming attacked by the prevailing disease.

Mental states.—Patients will occasionally become exceedingly despondent just before the period fixed for an operation, under a conviction that the result will be fatal. If, after a reasonable assurance, the mind cannot be disabused of this impression, the operation may be postponed. Such a state of mind not only operates against the patient's recovery, but also exercises a very depressing effect on the surgeon.

Profound grief, anger, fear, or great mental excitement are all unfavorable to the work of repair, whether existing at the time of or after the employment of the knife.

The deportment of a surgeon will do much to allay fear and inspire hopefulness in the heart of a patient. He should never underrate or overrate the dangers of an operation, but should be frank and honest in all his representations. Nothing is more contemptible, not to say wicked, than for a surgeon to treat the apprehensions or anxieties of patients with ridicule or levity.

Preliminary training.—It is frequently necessary, in order to secure the success of an operation, that some form of apparatus shall be worn. Many persons are so intolerant of restraint that they fret themselves into a state of nervous excitement whenever they are obliged to maintain an unusual posture. It is always well, in anticipation of such constitutional peculiarities, where an apparatus has to be worn, to have the instrument applied for a few hours at a time, and for two or three days before the operation is executed, that the person may become adjusted to the new position.

There is a class of operations designated by Mr. Paget "decorative," by the French "*opérations de complaisance*,"—*i.e.*, operations which are solicited from motives which relate to personal appearance or convenience: an opaque or collapsed eyeball must be removed in order that an artificial eye may be adjusted; a mole on the face, surmounted by a tuft of hair, becomes obnoxious and must be excised; a contracted finger will not admit of a glove, and must be got rid of; or the spermatic veins become slightly dilated, and nothing short of ligation will satisfy the mind of the patient. What is the duty of the surgeon in the premises? Many persons, either as a result of education or organization, are supersensitive in regard to any personal imperfection. There are men who would face a cannon with more courage than a varicocele, and there are women who would endure martyrdom rather than a mole on the face. It is, generally, useless to reason with such persons about the harmless nature of these infirmities, and there is no way to restore either their peace of mind or usefulness except by surgical skill. And that skill should not be withheld when there is a reasonable prospect of giving relief. I can recall some very curious experiences in this kind of surgery.

Having now briefly discussed the most important subjects connected with the undertaking of operations, I shall next consider some matters connected with their execution.

APARTMENTS—VENTILATION AND TEMPERATURE.—When possible, the room occupied by a patient about to undergo an important surgical operation should be large, well ventilated, and so situated as to command an abundance of sunlight. An open fireplace will always insure, in winter at least, the best interchange of air. The evils attending an insufficient amount of pure air are not properly appreciated. Much of the mortality of hospitals is to be attributed to this source of danger. The presence of a number of open and suppurating wounds is well calculated, by the putrescent emanations which they emit, to deteriorate the atmosphere of a ward or building; and hence arises the peril of overcrowding such places. Every patient, whether in or out of a hospital, should have not less than sixteen hundred or two thousand cubic feet of air, and this should be changed every twenty-five or thirty minutes, both day and night. The steam-fan in hospitals, and the open fireplace in all places, are the only perfect means of ventilation. The latter answers well during cold weather, when it is necessary to keep up a good fire, but is inferior to the fan, which, being in constant operation, is as effectual during the night, when the windows are closed, as in the daytime, when they are frequently open. In private houses the windows can be slightly opened above and below, so as to insure a proper atmospheric circulation, but no draught of air must be allowed to blow on or over the patient. Persons who have undergone severe surgical operations are peculiarly sensitive to alterations of temperature. In winter time the heat of the room should not be suffered to fall below 68° F. or to rise above 75°. Attention must be paid to rest, diet, and medication. One or more days of quiet both of body and mind, the proper regulation of food, which must be determined both as to quality and quantity by the peculiarities in each case, and the removal of all sources of intestinal irritation by a gentle cathartic, are subjects which demand special attention.

Patients who are robust, of a full habit, and with a strong, active circulation, should be put for a few days, when this is possible, upon a spare diet, chiefly farinaceous in its character. In other instances it may be necessary to administer tonics, stimulants, and anodynes, in conjunction with concentrated nourishment for some time, in order to enrich those constitutional resources which are to insure success after the operation.

ASSISTANTS.—In most operations it is necessary to have one or more assistants. The number will be specified in connection with special cases. When possible, the assistants should be persons familiar with the duties pertaining to the tasks to be assigned them in the operation; or, if not, they must be instructed by the surgeon, and the part assigned to each must be clearly designated before the operation is commenced, so that every want and contingency shall be anticipated, and no interruption or confusion occur.

The practice of making surgical operations a spectacle, by introducing a considerable number of medical men merely for the purpose of witnessing the performance, is reprehensible. It is calculated to disturb the composure of the persons to be subjected to the knife, and to give publicity to their diseases, which few are willing to allow.

THE TIME FOR THE PERFORMANCE OF AN OPERATION.—The middle of the day, or that period between eleven and one o'clock, is the time best adapted for an operation, not only on account of the light, but also because, in case any subsequent bleeding should occur, the surgeon may have daylight to aid him in his search for the source of the hemorrhage and the application of his ligatures,—a work very inconvenient and troublesome when done by artificial light.

It is probably best not to specify to the patient the particular hour when the operation is to be performed. He is too apt to look forward to its approach with feelings akin to those of a criminal contemplating the hour appointed for his execution.

PREPARATIONS FOR AN OPERATION.—Before commencing an operation everything necessary for its execution should be provided and in its proper place,

even to a sponge, or a thread, or a needle. Not only must this provision embrace the ordinary instruments and appliances required for the case in hand, but also those which under extraordinary circumstances may be needed. A surgeon exhibits his wisdom and foresight by anticipating all possible contingencies that can arise, and thus guarding and forearming himself against any surprise.

Not the least important agents which belong to the operating-table are restoratives, as ammonia, brandy, or whisky. In difficult and protracted operations the presence of an electro-galvanic battery will not be out of place, in the event of the respiration failing.

The instruments to be employed by the surgeon should be thoroughly cleansed beforehand, and subjected to a bath of carbolic acid before being used a second time.

The same scrupulous cautions should be observed on the part of the operator with regard to his own personal cleanliness, such as carefully washing his hands before commencing the operation, especially if he was previously engaged in dressing a wound. A surgeon who may be attending a case of erysipelas or of diphtheria is thereby rendered unfit to perform, or to assist in or be present at, any important operation, without first taking a bath and making an entire change of clothing.

Every patient should have his own sponges, and these must never be used a second time, unless they have been thoroughly disinfected in a carbolic acid bath. They should be allowed to remain in this bath during the interim of dressings.

In using the sponge, it should be first fully dipped in water and then squeezed thoroughly dry before placing it upon the wound, against which it should be firmly pressed—not wiped—and quickly withdrawn, so that the operator may not be delayed in making his incisions; or, if ligating, that he may distinctly perceive the point from which the blood issues.

The peculiar reticulated structure of the sponge (so well adapting it to catch and retain foreign matters), and the general carelessness in the use of this article, induce me to believe that little loss would be experienced if it were entirely discarded from use in surgical operations. I frequently employ as a substitute small pledgets of soft oakum, or, what is better, a plain, soft towel.

The table.—Most operations can be performed, with the greatest convenience, upon a firm, narrow table, which should be covered with folded comfortables or blankets.

All preparations should be made in an adjoining room, in order that they may not be witnessed by the patient.

As a rule, the etherization should be conducted while the patient is yet in bed, and in the presence of none save the surgeon and the assistant whose duty it is to administer the anæsthetic. When the anæsthetic has taken effect, the table may be introduced and the patient placed upon it. This done, the hair, if present, must be cleanly shaved from the parts involved in the operation.

The position occupied by the surgeon during an operation must necessarily vary according to its nature; it should, however, always be that which will enable him to perform his work with the greatest facility.

Before commencing an operation, the surgeon should have a clear and distinct plan of its details, as far as it is possible to form one. It is true that the most maturely arranged scheme may require material modification before the work is completed. But that fact does not lessen the necessity or the value of a preliminary plan. And, after the operation has once been commenced, the operator's undivided attention should be concentrated on the work in hand.

It should be executed expeditiously and deliberately, but without hurry or indecision. "*And now with God's help,*" was the expression used by an old master in our art when about to begin an operation; and it were well if

every surgeon, impressed with the solemnity of the moment, could honestly adopt the same language.

Anatomical demonstrations, or light, trifling conversation, are sadly out of place when a fellow-being is under the knife.

It is generally supposed that familiarity with blood renders the surgeon hard, pitiless, and insensible to suffering. There can be no greater mistake. It is true he may exhibit no emotion, and may give no vent to his feelings, either in words or in expression, yet within the few minutes of an operation are often compressed more intense sensations than are experienced by many persons during a whole lifetime.

Hæmorrhage.—It is important, in all operations, that as little blood as possible should be lost by the patient. Wardrop regarded the loss of blood as useful rather than harmful, and directed that a patient should be bled to fainting before commencing an operation,—a doctrine so monstrous as justly to tarnish his name to no small degree. The prevention of hæmorrhage does not, however, imply that a surgeon must stop and tie every vessel which is divided as he proceeds. Many branches will, after a few jets, contract and cease to bleed. Those that continue to bleed may be controlled by the use of *serres-fines*, or, better, by hæmostatic forceps. The employment of hæmostatic forceps not only greatly facilitates the execution of an operation, but also saves the effusion of blood, a matter of great moment in prolonged operations or when the subject is feeble. The assistant can apply them to the bleeding points without interrupting the operator, so that a mammary gland can be excised, or a large tumor removed, and no ligatures applied until the operation is completed.

When it is desirable to complete an operation before attending to the permanent control of the hæmorrhage, and there are no hæmostatic forceps on hand, a soft aseptic towel can be thrust into the wound and retained by pressure, as a tampon, and will be quite sufficient to arrest the bleeding at the time. The vessels can be tied by raising the towel a small part at a time and securing each artery as it bleeds.

When a patient during the progress of a tedious operation, either from loss of blood or from nervous exhaustion, grows pale and faint, and the respiration becomes feeble, the head should be immediately lowered to a level with the body, or even lower. If this change of posture is not sufficient to restore measurably the color to the face and lips and to improve the breathing, a more energetic respiration must be excited through the reflex action of the fifth pair of nerves. For this purpose the vapor of ammonia should be applied to the nose, and the face slapped with a towel wet with cold water, or water should be dashed over the surface.

If the surface of the body becomes cold and the symptoms of exhaustion continue to increase, brandy may be given by the mouth or thrown into the rectum, the circulation at the same time being invited to the surface by the application of external warmth. The use of ether or of whiskey hypodermically will serve to increase the power of the heart. Heated bricks or bottles of hot water rolled in flannel constitute the best means of applying artificial heat: they should be laid along the spine, between the limbs, and against the soles of the feet. Dry friction of the extremities with the hand also tends to impart heat and assist capillary circulation.

The free and general oozing of blood from the surface of a wound, which frequently delays the dressing, is often very promptly arrested by wetting a napkin in some hot water, squeezing out the redundant fluid, and placing it against the bleeding surface, retaining it for a minute in contact with the parts. After its removal the surface will present a blanched appearance. The proper temperature of the water is best determined by placing the napkin or towel, after being dipped in the hot water, against the side of the face or forehead: if not too hot to be borne by the assistant, it is ready for use.

DRESSING.—After an operation is completed and all bleeding has ceased,

the wound should be dressed as soon as possible,—that is, as soon as the surgeon has a reasonable assurance that no vessels have been overlooked which will be likely to bleed when the patient has recovered from the shock of the knife. While I am never in a hurry to close up a wound, I am not favorable to that practice which allows the parts to remain open for a considerable length of time or until the surface has become entirely glazed with a fibrinous film. There may, of course, be exceptions to this rule, as in deep and extensive wounds situated in important surgical regions. Ten or fifteen minutes are generally required to wash away the blood from the surrounding parts; and if, after this is done and the skin is well dried, no arteries are seen to bleed, the dressing may be commenced.

Before closing wounds of considerable magnitude, a drainage-tube should always be introduced, in order that any oozing blood or redundant serum may be promptly conducted away, and thereby the risks of suppuration be diminished.

The articles employed for the purpose of drainage should be of a quality calculated to produce as little irritation as possible. Those in common use are rubber tubes of different sizes, with holes cut out along the sides, catgut, and horse-hair. Before the introduction of any of these materials they should be treated with a solution of carbolic acid (acid 1 part, water 30 parts). Horse-hair can be inserted into a wound by placing the middle of a number of hairs in the notch of a probe and pressing them to the bottom of the wound. On the withdrawal of the probe the hairs remain. Glass tubes are frequently used for drainage, and are admirably suited for the purpose in many abdominal operations. A little rope of absorbent cotton passed into the tube facilitates the escape of discharges.

In operations external to the cavities of the body, the drainage-tube ceases to have any value after three or four days, and should be removed, either entire or in part.

If the operator employs the carbolic spray,—which, however, few do at present,—it should be continued until the wound is closed.

The dressings should, of course, be those already described as antiseptic, but, if circumstances render these impossible, compresses of patent lint soaked for some time in boiling water, or of lint well moistened with carbolated oil, may be substituted, though neither meets the demands of modern surgery, and their employment is likely to be followed by septic changes in the wound.

AFTER-TREATMENT.—There is a very great difference in the degree of pain experienced by patients after operations similar in kind. If there is only a little smarting, it will usually wear away in a short time, and requires no very special attention. If, however, the pain is severe, or the patient is nervous and restless, an anodyne is demanded, and may be given by the mouth or the rectum, or introduced subcutaneously, and repeated as often as is necessary to give relief and to restore tranquillity.

Pain is a powerful depressant, and there is a vast difference in the capacity of different persons to endure acute suffering. Sir Astley Cooper relates the case of a brewer's servant, a strong, robust man, who had been suffering several days from a thecal abscess, the result of a splinter which had run under the nail of the affected finger, and who, on the incision being made to evacuate the matter, fell back and immediately expired. Hunter saw a man die immediately after the loss of a testicle, apparently from the agony which he suffered. Before the discovery of anæsthetics doubtless many persons perished from the pain incident to tedious operations.

Diet.—A patient who has passed through the ordeal of a severe and prolonged operation, either with or without the loss of much blood, even though unconscious of the whole procedure, from having been under an anæsthetic, has nevertheless sustained a severe shock, the effects of which extend throughout the economy. How shall this evil be remedied? Some think the orderly operations of the different organs are best restored by an abundance of food

and stimulants. This must be accepted with considerable limitations. When there has been great loss of blood, the propriety of replenishing the emptied vessels by the free use of liquid nourishment admits of no doubt, and nothing fulfills the requirements of the case more perfectly than milk, to which may be occasionally added a little brandy or whisky. A little strong coffee administered from time to time forms a valuable adjuvant to our list of restoratives when there is an absence of that nerve-energy so necessary to establish reaction.

Next in importance after milk rank animal broths. These may be used after the lapse of four or five days, or when the surgical fever begins to decline. Eggs also constitute a most valuable article of nourishment, and are particularly indicated as soon as the stomach has recovered a reasonable degree of tone. While it is true that the patient needs a liberal supply of food to repair the waste incident to traumatic disturbance, it is no less true that in case of much shock being present, and until the harmonious action of the organs has been recovered, he may be greatly damaged by overfeeding. The course to pursue is not to press nourishment beyond the power of the patient to appropriate it. Rest is better than food, under such circumstances. Whenever a sense of nausea, of gastric distention, or of disgust is produced by food, it is best not to insist on its use, except in very small quantities and at short intervals, and when the stomach is very irritable rectal alimentation is to be preferred. The previous habits of a patient must in a great measure determine the treatment to be pursued after an operation. If the patient is addicted to the excessive use of liquor, stimulants cannot be safely withdrawn, and must be allowed to a reasonable extent. This is equally true with respect to opium-eaters: they cannot be deprived of the drug without serious detriment.

Medication.—The use of anodynes, as has been already stated, is important in all instances where the patient suffers pain or is restless after an operation. The quantity to be given of course depends on circumstances. As a rule, a full dose at once is better than a small dose often repeated; that is, where the symptoms are urgent. Tonics also, when the patient requires support, must be given, such as quinine, compound tincture of cinchona, and, in anæmic conditions, tincture of chloride of iron. As long, however, as a patient is doing well, drugs are an impertinence.

Removal of Dressings.—These, as a rule, are not to be disturbed earlier than the third day after the operation. If found to be unsoiled by the discharges from the wound, and the latter appears to be doing well, they may be allowed to remain for one or two days longer. There are other cases in which, in consequence of the leakage from the wound, the dressings become saturated and offensive, causing considerable local irritation: in such instances they should be removed and renewed without respect to time.

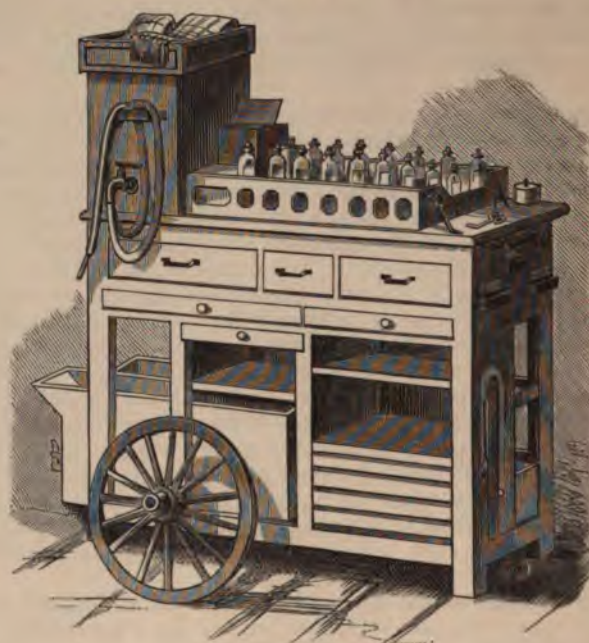
A vessel should always be at hand for the reception of the soiled dressings when removed; and, to destroy all unpleasant emanations, they may be sprinkled with a solution of permanganate of potash, of nitrate of potash, or of girondin, and immediately taken out of the room. The same course as to disinfection and removal from the chamber of the patient should be observed with regard to the alvine evacuations. It is only by the prompt removal of every soiled article from the apartment that the atmosphere can be preserved in a condition fit for the respiration or safe to the life of a surgical patient.

While these injunctions affecting the articles of dressings are to be enforced with scrupulous care, the clothing of the patient and his bed-linen demand equal attention. These must be changed every two or three days, taking pains to have those which are to take their place well dried and warm before they are used.

In hospitals the wagon of Morton will be found exceedingly useful, as it contains, in a very compact form, everything that is necessary for the reception of soiled dressings and the renewal of fresh ones, and can readily be wheeled

from bed to bed. Fig. 1123 represents a modification of this wagon by Dr. Hart, used in the hospital of the University of Pennsylvania.

FIG. 1123.



Morton's hospital wagon.

Many persons, after operations, complain of great soreness of the limbs, also of pain and stiffness in the back. When the change of bed and of personal clothing is made, nothing will so much contribute to the relief, comfort, and refreshment of the patient as to have the body well rubbed with alcohol. Friction of the limbs, made by the hand, will often exercise a good influence in calming nervous restlessness and inducing sleep. When pain or distress over the lumbar spine is severe, a mustard-plaster applied for twenty-five minutes over this region will frequently give relief.

Accidents during and after Operations.

EXHAUSTION.—Notwithstanding every possible precaution, an operation may be so prolonged, on account of the attachments and relations of a growth, that a large amount of blood will be lost, in consequence of which a dangerous exhaustion will ensue. Or the latter condition may occur without hemorrhage, as a result of shock or failure of the necessary nerve-force. This may follow a double amputation, the extirpation of a large and deeply-seated tumor in the neck, or a complicated case of lithotomy. Many persons, doubtless, before the discovery of anæsthetics, perished from the depressing effects of pain. It must, however, be remembered that although the employment of anæsthetic agents may prevent all consciousness of suffering, they do not exempt the organs of the body from shock; and on this account it is very necessary, even though no expression of pain may escape the patient while under the influence of ether or chloroform, that the operation be executed with as little delay as possible.

When the exhaustion is the consequence of the loss of blood, the dangers which environ the future of the case are greatly enhanced, even though the

patient should rally from its immediate effects. The system thus reduced is peculiarly liable to pyæmic infection, erysipelas, gangrene, and various forms of low inflammations.

The exhaustion following an operation is generally indicated by a death-like pallor of the face, a feeble pulse and feeble respiration, sighing, indistinctness of vision, an upward rolling of the eyes, noises in the ears, coldness of the limbs, excessive restlessness, and often by vomiting.

To meet such an urgency, it is necessary, first, that the *function of the brain* shall be maintained. The patient must, therefore, be placed in the recumbent position, with the head low, and, in extreme cases, with the lower extremities and the body raised so as to determine the blood to the head. Bottles of hot water rolled in pieces of flannel should be applied between and along the sides of the limbs, and to the spine. A sinapism may be laid over the epigastrium, and dry friction addressed to the extremities. Brandy or whisky should also be given by the mouth, or, when deglutition is impossible, by the rectum. These stimulants can often be given in milk or in strong coffee.

Anodynes are of the greatest importance in such cases, and may be introduced into the system by the mouth, by the rectum, or subcutaneously. In the employment of both stimulants and anodynes the surgeon must be very discreet. Neither should be given in large quantities or be too frequently repeated. Absorption, in the condition of the system under consideration, may be temporarily suspended; and hence these agents may accumulate, and after a time, when reaction has begun to set in, they may induce, in the first case, a dangerous excitement, or, in the case of anodynes, a fatal depression.

When the exhaustion is the result of excessive hemorrhage, the *transfusion of blood* may be adopted with some prospect of benefiting the patient. Patients do sometimes die while under the knife. Death under such circumstances may be due to exhaustion, to the effects of an anæsthetic, or to some concealed organic disease which had escaped detection. Such an event, however induced, must be looked upon as a great calamity. God grant it may never be a part of my personal experience!

HEMORRHAGE may follow shortly after the closure of a wound. When this is the case, it is generally attributable either to some vessel having been overlooked, or to the closing of the parts before reaction has been sufficiently restored to test the security of the vessels. It is always an unfortunate circumstance to be compelled to reopen a wound once closed. Even if done only a few hours after its adjustment, it complicates the subsequent process of repair. For this reason the part should be elevated when it is possible to do so, cold applied, and pressure made with a bandage. These measures failing to arrest the flow, the wound must be opened and the source of bleeding sought for and controlled: there is no alternative.

ENTRANCE OF AIR INTO A VEIN.—This is a dangerous occurrence. It will be best prevented by encircling the vessel, when its division becomes necessary, with a ligature, both above and below the point where it is to be severed.

Should this accident occur during an operation on the neck, the head of the patient should be immediately lowered, and stimulants administered by the rectum, at the same time keeping up artificial respiration. (See vol. i. p. 517.)

EMBOLISM.—After operations in which much blood has been lost, there is always more or less tendency to the formation of coagula. This may take place in the vessels of the extremities, and, by forming an obstruction to the circulation, cause the limb to fall into a state of gangrene. From the same tendency to coagulation of the blood a clot may form in the heart sufficiently large to destroy life. I have seen both these accidents occur. It is of the first importance that patients thus predisposed should be kept perfectly quiet and in the recumbent posture.

Any considerable effort, such as sitting up in bed, when the power of the

heart has been much lessened and the vessels deprived of a large amount of blood by an operation, exposes the individual either to a fatal syncope, or to the formation of obstructive plugs of fibrin.

Alarming symptoms sometimes follow the use of anæsthetics, which will be considered under the head of anæsthesia.

There are accidents which follow operations and which materially add to the mortality of surgical cases. They are as follows:

SECONDARY HEMORRHAGE.—This is generally occasioned by sloughing, or by a diseased state of the artery. The period of its occurrence is rarely earlier than the seventh day or later than the twentieth day after the operation. There are, however, exceptions to this rule. In view of such a contingency, the surgeon should never fail to be prepared for the emergency. When there is any reason to apprehend this accident, as where the wound assumes an unhealthy appearance, or where the vessels were found to be in an atheromatous condition at the time of their ligation, the surgeon should give detailed directions to the nurse or other assistants how to act should the necessity arise; he should instruct them in the management of the tourniquet, previously placed loosely over the principal vessel of the limb, or, if this is not feasible, in the preparation of a graduated compress, to be thrust forcibly into the opening from whence the blood issues, and there held firmly by the fingers until the presence of a medical attendant can be obtained. The subsequent course to be pursued must depend on the peculiarities of the individual case. Sometimes it may be necessary to ligate the vessel in the wound, at other times the artery above. Occasionally, the removal of the limb may offer the only chance of recovery.

MANIA A POTU.—In persons of notoriously intemperate habits an injury or an operation will invite an attack of alcoholic mania or delirium tremens.

Treatment.—Opium, bromide of potassium, and chloral are the remedies which are found most efficient in controlling the nervous symptoms. One grain of opium, or its equivalent, twenty-five drops of laudanum, may be given every two or three hours until sleep is induced. Twenty grains of bromide of potassium, with fifteen grains of chloral hydrate, dissolved in some mint-water with a little syrup, and given every two hours, will often secure a quiet sleep. Morphia may be given hypodermically when there is much irritability of the stomach. One-fourth of a grain may be deposited in this way (under the skin) and repeated once every three hours until the narcotic effect is realized.

In cases attended with violent tremors, the addition of some antispasmodic to the anodyne, such as the ammoniated elixir of valerian or the tincture of hops, will be found to have a very happy effect in calming the excitement. It is possible, however, to carry the opium treatment to an injurious extent, in over-anxiety to bring the patient quickly under its influence, by increasing the dose of the drug too rapidly, or by exhibiting it too frequently.

When the conjunctiva becomes injected, with a turgid face and throbbing temporal arteries, a blister to the back of the neck will be found useful. In persons who are feeble and broken in health from intemperance it is better not wholly to withdraw the accustomed stimulus, but to allow a little whisky or other alcoholic drink from time to time. It is also highly important that nutritious liquids be administered during the attack, not only as a means of sustenance, but also with a view to diminish that insatiate thirst and craving for drink which pursues the unfortunate victim like an unrelenting demon.

HYSTEROIDAL DELIRIUM.—There is another form of delirium which partakes of the nature of hysteria, and seems to depend on a loss of the moral inhibitive power, occasioned by shock. It may be either of a *quiet* or of a *boisterous* kind. The first is most common in persons of advanced life who have undergone operations; the second in adults.

The passive delirium manifests itself by hallucinations and rambling conversation and restlessness. The patient conceives himself to be in a strange room, is constantly asking to be taken home, imagining strange persons about the bed and strange faces on the wall, and frequently endeavors to unloose

or tear off the dressings. I have in two or three instances seen these mental delusions harass patients for some time after the operation for cataract.

The boisterous variety is often a sudden intrusion, and is more common in females than in males. The patient laughs or cries, sings, prays or exhorts, at one time is harassed with muscular tremors, and at other times with violent contortions of the body. These eccentric exhibitions are injurious to the patient by interrupting that mental and physical quietude which is so important after operations.

In the quiet form of traumatic delirium there is evidently some cerebral anemia present, which is most satisfactorily removed by stimulants, together with opiates and antispasmodics. In the violent form, the bromides with the antispasmodics are the proper remedies.

TETANUS is not a common sequel of operations. When it has occurred in my hospital experience, I have had every reason to believe that it was to be referred more to the effects of the injury which necessitated the use of the knife than to the operation itself. The infrequency of the disease in temperate climates may be illustrated by the fact that during thirty-two years at Guy's Hospital the number of cases of tetanus did not exceed one case in 1575 patients. In the Pennsylvania Hospital the disease, as a result of operations, is almost unknown. In tropical countries, however, the prevalence of the disease is very great, children being especially disposed to such attacks. The mortality in India and tropical America from this cause has been particularly noticed by writers.

The remedies to be employed in tetanus are cathartics, followed by the use of opium, bromide of potassium, and chloral hydrate. Nourishment and stimulants are also of the first importance, as a means of sustaining the system, in the hope that the disease may exhaust itself.

When the jaws are locked and food cannot be introduced into the mouth, it may be conducted into the pharynx and œsophagus through the nasal passages, by means of a flexible tube.

If there is reason to believe that a nerve has been pricked, or included in a ligature, it should be laid bare and divided across.

RETENTION OF URINE, though not in itself a dangerous occurrence after an operation, is a very common one: hence the condition of the bladder should be inquired into at each visit, and the catheter employed whenever the patient is unable to empty the viscus.

MUSCULAR SPASMS occasionally follow an operation, involving certain groups of muscles, or affecting those of an entire extremity.

A change of position, a firmer application of the roller, or a subcutaneous injection of morphine will generally afford the necessary relief.

From what has been said it will be obvious that the success of an operation depends upon many contingencies. Patients will die, and no amount of skill or human foresight can prevent it. It is the will of Providence that this should be so; and, if the surgeon is conscious of having fulfilled his whole duty in the premises, without an error of omission or of commission, he can reverently and submissively bow to the Almighty fiat, with a conscience void of offense towards God and man.

CHAPTER XIX.

ANÆSTHETICS.

NOTHING is more dreaded than pain. All nations, from the most savage to the most civilized, have their pain-destroying remedies. To render a surgical operation a painless procedure has been a dominant thought in the minds of physicians from the remotest times, as will appear by reference to the early records of the art. For this purpose the Greeks, Romans, and Arabians employed the volatile principles of narcotic plants, such as the mandragora, stramonium, hyoscyamus, and others of a like class. The method of employing these agents was not unlike that now in use in administering our well-known anæsthetics. Theodoric is represented as directing the inhalation of vapor from a sponge previously saturated with a decoction of various narcotic substances. At St. George's Hospital, London, John Hunter put into execution the suggestion of Mr. Moore for the prevention of pain in surgical operations, by making powerful pressure over the chief nerves of a limb by means of a tourniquet. The limb was amputated while thus constricted, and, it is said, with only a trifling degree of suffering.

Among the Chinese, and still later with the Mohammedans, the Indian hemp was used for the same object. In more recent times, the experiments of Sir Humphry Davy with nitrous oxide gas, first published in 1800, appear to have opened a new field in this kind of inquiry. This agent was found to have the property, when taken into the respiratory organs, of destroying pain. The interest attracted to the subject, however, after a short time subsided, and, like the germs of many other discoveries, it passed for a time into oblivion.

Wardrop, of London, recommended the copious abstraction of blood previous to an operation, with a view to lessen sensibility. I have seen the carotid artery tied in a person who had lost a large amount of blood from a wound in the neck without any manifestation or sign of pain on the part of the patient. But the adoption of such a degree of depletion for the object contemplated is too hazardous to be entertained for a moment by any sensible person. Before the introduction of our present anæsthetics, it was the custom of most surgeons to administer to their patients, previous to the operation, a large dose of opium or of some of its preparations. The effect of this was to diminish both the severity of the pain attending the use of the knife and the mental excitement incident to the performance of the operation.

In 1844 a dentist of Hartford, Connecticut, Dr. Horace Wells, revived Sir Humphry Davy's discovery, by inhaling in his own person the nitrous oxide gas, and, while in an insensible state, having a tooth extracted without the least consciousness of pain. Similar operations, and with a like result, were performed by Dr. Wells on a number of patients to whom he administered this gas. Notwithstanding the signal success which seems to have then attended the use of this agent, it again fell into discredit, in consequence of the indifferent success attending some experiments before the faculty and students of Harvard University.

In 1846, Dr. Morton, who was a student of Dr. Wells's, was led to try the effect of inhaling the vapor of sulphuric ether as a means of destroying sensibility. His first experiments were made upon himself, and afterwards on others, his patients. After a number of trials he succeeded in establishing to his

own satisfaction both the safety and the certainty of ether as a pain-destroying agent. Like his master, Dr. Wells, he was next to subject the matter to a public trial. The conflicting emotions which stirred his nature may well be imagined. If the experiment proved successful, his name would be rendered immortal; if he should fail, only ridicule awaited him. The exhibition was given at the Massachusetts General Hospital, on a patient from whose neck Dr. John C. Warren was about to remove a tumor. The ether was administered, and the operation performed while the man lay unconscious of the whole procedure. A second experiment was made on a patient of Hayward's, with a similar result. Such were the circumstances attending the discovery and introduction of anæsthesia. Who can measure the importance of this signal event to the human race! It remained for America to confer this great boon on suffering humanity. How many monuments have been raised to perpetuate the names and commemorate the prowess of martial heroes who have stained the earth with the blood of slaughtered men and have sent a wail of woe over entire continents! But where is the pillar or modest column meeting the eye of native-born or foreigner to tell the tale of two humble dentists whom God enabled to invent a sleep that antidotes every pain? Ungrateful nation! the names of Wells and Morton will never be forgotten, though no memorial stone or enduring shaft shall rise at thy bidding.

In Philadelphia, Dr. Peace is said to have performed the first operation under ether (a reduction of a dislocated shoulder) upon a patient in the Pennsylvania Hospital. The public excitement attending the discovery of the anæsthetic properties of ether spread rapidly on both sides of the Atlantic. In England, the first operation under ether (an amputation of the thigh) was done at the University College Hospital, by Liston, December 22, 1846, and the year following, 1847, Sir James Simpson, of Edinburgh, discovered chloroform.

The advantages resulting from the use of anæsthetics are incalculable. The certainty of being able to pass through an operation without experiencing any pain relieves the mind of that dreadful anxiety and alarm which would otherwise disturb the nervous system of a patient. Fear and pain are both powerful depressants. And it is quite apparent that the inordinate development of nervous excitability, incident to the social life of our people, renders the exhibition of anæsthetics more imperative at the present time than it would have been when men and women were cast in a rougher mould and were trained under less artificial modes of living.

The moral shock attending an operation is also greatly lessened. What a painful and embarrassing trial would it be to a refined and sensitive woman to be compelled, with a full consciousness of all that was taking place, to undergo any of those tedious operations for the relief of diseases peculiar to her sex, and in which some personal exposure is unavoidable! The use of anæsthetics is exceedingly important, not only in preventing suffering while examinations are being made, but in enabling the practitioner to reach a correct diagnosis, by suspending sensibility and those voluntary movements which ordinarily so vitiate and complicate the investigation of surgical cases. Again, anæsthetics, by securing the passivity of the patient and allowing the most deliberate and precise use of the knife, contribute to both the safety and the completeness of operations executed in dangerous regions. Cutting operations performed without the use of an anæsthetic not only inflict pain at the time of their execution, but are followed by severe burning pain for a long time afterwards, requiring often large and repeated anodyne doses before relief can be obtained. A patient, however, who is rendered insensible previous to the use of the knife recovers sensibility slowly, and consequently the severity of the pain is in a great measure past before the effects of the anæsthetic disappear, thus making the administration of opiates unnecessary, except to a moderate extent.

Has the use of anæsthetics lessened mortality in surgical operations? is a ques-

tion which has been frequently asked. Sir James Simpson, after a somewhat extended investigation of this subject, came to the conclusion that the death-rate was diminished by their employment. Dr. Arnott, on the other hand, reached a different conclusion, affirming that the mortality has been increased. Bryant has analyzed 2586 capital operations performed prior to, and 1847 executed since, the introduction of anæsthetics, showing that the results as to mortality are about the same. The records of the Pennsylvania Hospital exhibit a greater death-rate since than before the use of these agents. It must, however, be borne in mind that the introduction of massive machinery into our manufacturing establishments and the multiplication of railroads have materially changed the character of the injuries for which operations are required at present.

Precautions in the Use of Anæsthetics.

First. The article used should be perfectly pure. All mixtures of these agents are improper. Should an accident occur, it would be impossible to know upon which ingredient of the mixture to lay the blame.

Second. The anæsthetic which experience has proven to be the safest should be selected. The surgeon is bound by the highest moral considerations to do this, and his patient has a right to expect that it will be done.

Third. The administration should be the office of one assistant, and of one, too, who is entirely familiar with his duty. And his attention should never be diverted from the work on hand as long as the continuance of the influence of the anæsthetic is required. It is an immense relief to the mind of a surgeon to feel that his attention can be concentrated wholly upon the operation, and that he can perform it without the distraction of having to watch the inhalation.

Fourth. A third person should always be present during the administration of an anæsthetic, especially when the agent is administered to females. This precaution is absolutely necessary in order to preserve the character of the practitioner, as the patient may have the sexual appetite so excited under the stimulus of the anæsthetic as to imagine herself to have been the helpless victim of personal violation. Charges of this nature have been made by females in several instances, in all of which there is good reason to believe the charges were entirely unfounded, the offense imputed existing only in the imagination of the patient.

Fifth. It is highly proper that the anæsthetic be administered to the patient while in the recumbent position (especially when chloroform is employed), and that a free access of atmospheric air be allowed.

In the use of ether this is not so imperatively necessary.

In operations on the mouth and jaws the semi-recumbent attitude may be adopted.

Sixth. No solid food should be allowed for four or five hours before the exhibition of an anæsthetic. The apprehension usually entertained by the patient before an operation almost always suspends digestion; and a loaded stomach is most certainly followed by vomiting, both during and after the action of the anæsthetic. The presence of solid food also favors cerebral congestion, and interferes with free respiration by encroaching upon the cavity of the thorax.

Seventh. It is necessary also to have the clothing about the neck and body entirely loose. If artificial teeth are worn, they should be removed beforehand. Neglect of this last precaution may be followed by serious consequences, from the plate becoming displaced and dropping into the pharynx.

Eighth. As conversation is calculated to disturb that mental quietude so necessary to the rapid production of anæsthesia, it is desirable that no conversation be indulged in by the surgeon, or by those about the patient, at least until the loss of consciousness begins.

Ninth. In cases where the patients are much exhausted, the administration

of half an ounce or an ounce of good whisky or brandy, before the anæsthetic is given, will be of great value.

Tenth. When the anæsthetic is administered at night, requiring the use of artificial light, it must not be forgotten that the vapor of ether will descend, and on this account the candle, lamp, or gaslight should be held above, not beneath, the inhaler. Chloroform is not inflammable, and hence does not require the same caution in the use of artificial light as does ether.

Eleventh. In cases of ankylosis of the lower jaw, and when an operation is contemplated, it is not safe to give an anæsthetic unless the stomach is quite free from food. I have seen a person, from inattention to this point, wellnigh perish, by reason of the surgeon's inability to get anything into the mouth to clear out the pharynx, which had become obstructed by materials rejected by the stomach while under ether.

SUPPOSED CONTRA-INDICATIONS TO THE USE OF ANÆSTHETICS.—There are very few conditions in which an operation is necessary under which anæsthetics cannot be given with safety, particularly sulphuric ether. It has been thought that in valvular disease of the heart, or in fatty degeneration of that organ, the use of anæsthetics is contra-indicated; but in my experience I have not found this to be the case. The physiological effect of ether is to impart tone to the heart, and to increase the vigor of its action.

Chloroform being a depressant to the central organ of the circulation, its administration in cases of structural alteration, either in the valves or in the walls of the heart, is not unattended with danger.

In cerebral congestion or inflammation, or where intense headache exists, it is best to withhold the exhibition of either sulphuric ether or chloroform.

The depression attending shock does not contra-indicate the use of an anæsthetic, though here, as in heart disease, ether is to be preferred to chloroform, and for the same reason, viz., that it does not diminish the power of the circulation, but rather increases it. Without an anæsthetic, the use of the knife before a patient reacts is calculated to intensify the shock, as pain in itself is a serious depressant.

In cases of bronchitis, the use of anæsthetics, especially ether, is generally followed by an aggravation of the cough; but this is not sufficiently important to preclude their use. The same is true of tubercular disease of the lung.

Persons who suffer from epilepsy are not thereby disqualified for the use of anæsthetics. Even should the latter excite a paroxysm of the disease, no evil effects remain. I have seen such attacks take place while trephining a patient for epilepsy; they were apparently excited by the etherization.

Ether may be given with impunity to persons suffering with renal disease.

In cases of children suffering from croup, when there is extreme exhaustion, coupled with great mechanical obstruction to the entrance of air, and the operation of tracheotomy is demanded, the anæsthetic must be withdrawn after the incision is made through the integument.

In all cases where patients are greatly enfeebled, a very small amount of ether or chloroform will produce the characteristic effects. This fact must not be overlooked when, under such a condition, it becomes necessary to anæsthetize a patient.

Anæsthetics may be divided into *general* and *local*.

General Anæsthetics.

A considerable number of chemical compounds are known to possess anæsthetic properties; but those ordinarily employed in practice are sulphuric ether, chloroform, nitrous oxide, a mixture of chloroform and ether, the bichloride of methylene, and ethidene.

Ether.—Sulphuric ether, to be pure and suitable for the purpose of inhalation, should have a specific gravity of 0.720.

Phenomena attending administration.—1. The first of the effects attending the administration of sulphuric ether is an undue irritation of the lining membrane of the respiratory passages, causing a slight cough and a sense of suffocation, generally of short duration and soon followed by a factitious state of insensibility. Dr. Flagg and Dr. Packard, of this city, have called attention to this condition, as one of which advantage may be taken for opening abscesses and for performing other operations requiring only a moment for their execution.

2. This state is soon followed by another, in which the nervous system participates. The symptoms are usually those of pleasurable excitement, manifested by laughter, extravagant expressions or exclamations, accompanied or followed by more or less muscular and facial contortion, and often by violent struggles. The behavior of a person is much influenced by natural mental and moral peculiarities. The dominant proclivities usually crop out as the intoxication begins. The sedate and sober-minded rarely make any extravagant demonstrations, while those of a jovial or rollicking disposition are usually boisterous. During this stage of excitement the pulse quickens, the pupils contract and dilate, the respiration is conducted sometimes quietly, almost inaudibly, and at other times in a full, noisy manner. The limbs are frequently rigid, or may be agitated by tremors. Often at this period the surface of the face, neck, and breast becomes blotched with patches of erythema, attributable, doubtless, to some excitation of the cutaneous nerves.

3. Next follows the stage of relaxation and insensibility. The limbs begin to lose their rigidity, becoming relaxed and limp, so that the arm or the leg, if raised, drops helpless upon the withdrawal of the support. The respiration becomes long, slow, regular, and attended with snoring; the urine occasionally escapes from the bladder; the pulse, at first frequent, now becomes slower and fuller, and the pharyngeal glands are stimulated to unusual activity, causing a large accumulation of a tenacious, mucous secretion in the fauces and throat. Not unfrequently a purple, livid, or leaden color appears on the face and lips. The parts which seem to lose their sensibility last are the conjunctiva and the genital organs.

Time.—The time required for producing complete anæsthesia by ether varies very much in different individuals, some requiring not more than from six to eight minutes, while others are affected only after twenty or twenty-five minutes. The average time I find to be about fifteen minutes, the amount of ether consumed varying from four to five ounces.

Recovery.—The manner in which recovery takes place from the anæsthesia of ether or chloroform differs in different cases. In some instances, patients will awake quietly out of sleep, at first a little confused or bewildered, but soon able to collect their thoughts in an orderly manner, and to speak intelligently, though having not the least idea of time, and exhibiting great surprise or incredulity when told that the operation or examination is over, requiring again and again to be assured of the fact. Others, unless roused by a shake or addressed in a loud voice, will continue quietly to sleep for half an hour or longer after the withdrawal of the anæsthetic; while in other cases recovery is characterized by wild, incoherent, or ludicrous talk, by extravagant expressions of gratitude, and often by hysterical sobbing.

MODES OF ADMINISTRATION.—Various mechanical contrivances have been devised from time to time for administering ether. Among these may be mentioned the *inhalers* of Lente, of Allis (Fig. 1124), of Goodwille, of Clover, and others.

That of Dr. Allis consists of a wire or a metal frame, over which a roller bandage is stretched by recurrent turns, and the whole inclosed either by a metal or by a patent-leather cylinder, fashioned at one end so as to fit over the face. The ether is poured over the layers of muslin which are stretched across the apparatus from side to side, and which necessarily expose a large surface for the escape of the vapor. Dr. Albert Smith bisects a large gum ball and lines the half to be used with cotton flannel. I do not, however,

believe that we possess a more simple or satisfactory appliance for the administration of ether than that of a simple cone formed out of a large table-napkin or a medium-sized towel. (Fig. 1125.) I never employ any

FIG. 1124.



Dr. Allis's inhaler.

FIG. 1125.



Cone formed out of a towel for inhaling ether.

ether contrivance. It may not be the most economical, but it is very much the most convenient, and is always attainable.

The early effects of the anæsthetic, such as the irritation of the respiratory passages and the sense of suffocation usually experienced, should be explained to the patient before its administration, and he should be assured that these sensations are temporary, will soon pass away, and need cause him no alarm. Instruction should also be given him as to the manner of taking the anæsthetic, that is, by moderately forced or deep inspirations and expirations.

As the action of ether is sometimes irritating to the skin when brought in contact with it, it is well to smear a little cold cream or sweet oil over the exposed parts of the face before the inhalation begins. After sprinkling two or three drachms of ether over the inner surface of the cone, the latter should be placed over the mouth and nose, leaving space sufficient between the two for the free admission of atmospheric air. This plan is much to be preferred to that in which the inhaler is held close down upon the face, which must necessarily not only cause great irritation of the respiratory organs, but also produce a sense of terror and provoke resistance in the patient. As the inhalation progresses, in a little time the air-passages become less sensitive, and the ether-napkin may be allowed to rest upon the face. Every two or three minutes the cone must be replenished with the anæsthetic. Sometimes the breathing is carried on in a silent and quiet manner, and it becomes necessary to rouse the consciousness of the patient by pressing the thorax, by shaking the body, or by a command sufficient to let him understand the necessity for a more vigorous respiration.

Should the patient in the early stage of intoxication manifest much excitement, a gentle, assuring word, with or without the passage of the hand softly over the forehead, will generally restore quiet and confidence. Except when the individual persists in attempting to seize the hands of the administrator, or to put away the inhaler, it is better not to hold the arms or the legs, as the very feeling of restraint will only provoke resistance. When given in the gradual manner, the full effect of the anæsthetic can be obtained without creating any serious struggle; and whenever the long, snoring respirations begin, the insensibility may be considered complete.

CAUTIONS DURING THE ADMINISTRATION.—The collection of tenacious mucus, which frequently forms in the pharynx during the exhibition of ether, should be cleared away from time to time. This can be most conveniently done by the finger covered with a linen cambric handkerchief.

If the face becomes cyanotic from venous congestion, the anæsthetic should be immediately removed until the proper color is restored. A long inspiration usually induces this change very promptly.

Vomiting may occur both during and after the administration of the anæsthetic. In the first instance it is usually announced by short, convulsive movements of the muscles of the abdomen. These signs do not, however, necessarily require the removal of the ether. On the contrary, by continuing the anæsthetic the vomiting can often be prevented. When such is not the case, the ether must be immediately suspended, and not re-applied until the stomach is unloaded.

Occasionally the vomiting is preceded by a marked pallor of the face, a cold, moist skin, with a feeble respiration and a slow pulse, after which the matters are suddenly ejected from the stomach. When these symptoms appear, the ether must be removed until vomiting is over, and care taken to clear the throat of whatever particles of food may not have been discharged.

Should breathing become short and stertorous, and the face purple, it will become necessary to withdraw the anæsthetic at once. If the respiration is not quickly re-established, the tongue should be seized and drawn out of the mouth by the forceps or a tenaculum. This must be done in order to open the glottis and thus allow the air to pass into the lungs. The breathing may be excited by slapping the face, neck, and breast with a towel dipped in cold water. If these precautions are not sufficient to remove and avert the asphyxia which is now impending, resort must be immediately had to artificial respiration, by the Marshall Hall or the Sylvester method. It is in such emergencies that the electro-galvanic battery can be used with great advantage, by passing the current along the phrenic nerves and over the wall of the thorax. If the threatening symptoms do not disappear, brandy or whisky should be thrown under the skin or into the rectum.

AFTER-EFFECTS.—The most common sequels of ether inhalation are nausea and vomiting, headache, and sometimes an irritating cough. In females nervous symptoms of a hysterical nature are frequently witnessed.

In relieving the nausea and vomiting it is scarcely necessary to prescribe any remedies: half an hour or an hour will usually suffice for these to wear away. If, on the contrary, they are persistent, nothing will more satisfactorily secure relief than a hypodermic injection of morphia. One drop of dilute hydrocyanic acid or five drops of chloroform in a little mint-water will also be found to act well. Salicylic acid in doses of six or eight grains, dissolved in a solution of citrate of ammonia and given at intervals of half an hour, often has an excellent effect. Effervescent draughts, lime-water, etc., I have never seen productive of much good. The headache usually requires a night's rest for its removal; but some relief will be afforded by administering aromatic spirit of ammonia in camphor-water. Ice-water applied to the head will usually aid in alleviating the pain.

The cough is generally due to nothing more than bronchial irritation, which will subside in an hour or in less time. When this does not occur, and the cough continues for several consecutive hours, it is probably owing to the presence of pulmonary congestion, which in turn may end in pneumonia. Such terminations may be encountered in old persons with feeble hearts. Counter-irritation by mustard-plasters should be applied over the chest, and, to quiet the cough and equalize the circulation, a mixture containing carbonate of ammonia, morphia, and tincture of digitalis should be given. Wine-*whew* or other stimulants should also be used.

Hysterical exhibitions are best mastered by a hypodermic injection of morphia, or, if this cannot be conveniently administered, by bromide of potassium, either with or without elixir of valerian.

Chloroform.—Chloroform is perfectly limpid, colorless, and non-inflammable. Its tendency to deteriorate by exposure to light, especially when it is of a certain density, suggests the propriety of keeping this agent in a dark place.

The physiological action of chloroform on the nerve-centres varies at different stages of its administration. At the early period, or that of *excitation*, the vessels of the brain become greatly congested; but as the insensibility progresses, the vascular fullness is exchanged for a state of diminished tension, so marked, indeed, that the encephalon becomes paler than in the normal condition. With this appearance of cerebral anæmia, consciousness, sensation, and voluntary movements begin to fail, though reflex motility may for a short time become more active in the voluntary muscles. Although the medulla spinalis is slightly affected almost simultaneously with the brain, yet as the anæsthesia progresses its effects upon the spinal cord become more and more prominent, so that the reflex excitability of the muscles of animal life is suspended and the limbs lie utterly relaxed and powerless. Notwithstanding this complete paralysis of the voluntary muscles, the heart and those muscles which carry on the work of respiration continue to perform their functions.

It is said that sensation and voluntary movements may be destroyed and yet consciousness remain,—a fact which would seem to indicate that chloroform may affect the spinal cord independently of the brain. I have never seen this condition. That the sensibility may be benumbed and the patient at the same time be conscious, so that slight pain is not experienced to a degree sufficient to excite muscular movements, is unquestionably true. But, if a suture be introduced during the continuance of this condition, it will be found that the puncture of the needle is followed by unmistakable manifestations of pain.

Of the manner in which chloroform suspends sensation we know very little. Bernard supposed this to be effected by a temporary coagulation of the contents of the nerve cells, and that the gradual return of sensation was from the restoration of the neurine to its original state. This explanation, with others which might be mentioned, is purely hypothetical and requires no further notice.

The effect of chloroform is that of a depressant, acting, through the ganglionic system, directly upon the heart, and causing a notable diminution in the force of the latter.

MODES OF ADMINISTRATION.—Various appliances are used for administering chloroform. It is sometimes poured over a sponge inclosed in a cone formed out of a towel. But the simplest and perhaps the safest plan is to use a small cone made out of a napkin or linen cambric handkerchief, sprinkling a small quantity of the anæsthetic, not exceeding half a drachm, from time to time over the inner surface of the cone, allowing ample space between the latter and the face for the free admission of atmospheric air. The attention of the administrator should never for a moment be withdrawn from his work. The pulse, the respiration, and the color of the face are the three important things to be closely observed.

Chloroform should never be administered to a patient except in the recumbent position. The chest and neck must be free from all constriction.

The amount of chloroform required to produce full anæsthesia will vary in different persons. Those who are in the habit of indulging freely in alcoholic drinks or in opiates will require considerably more than those who abstain from such excesses. From two drachms to half an ounce is the quantity usually demanded. The time necessary for the anæsthetic to take full effect ranges from four to seven minutes.

Phenomena attending administration.—A short time after the inhalation is commenced, some slight excitement occurs, manifested by rambling ejaculations, rigidity, and muscular struggles. These are generally of short duration.

The pulse, at first a little hurried, soon becomes slower and weaker; the breathing is deep and sometimes noisy; the vessels of the face and of the ocular conjunctiva are seen to be congested; the eyes are suffused with tears, and in a short time the patient passes into a state of insensibility and unconsciousness.

Recovery from the state of insensibility is in most respects like that following the use of ether, except that in the latter the intoxication is more protracted and more liable to be followed by vomiting.

Symptoms frequently occur during the administration of chloroform of a character which will demand immediate attention. These may proceed, it is said, from three different sources, viz., the brain, the lungs, and the heart. I am disposed to think that the heart is primarily involved in most cases in which alarming symptoms appear, and that the brain and lungs suffer secondarily. These symptoms may be slight, or they may be severe and sudden. When arising from what is regarded as cerebro-spinal poisoning, the breathing becomes stertorous and the countenance blue. In most instances the removal of the anæsthetic and the free admission of air will suffice for the patient's relief. Should this be otherwise, the danger to life is imminent: both the respiration and the circulation may suddenly cease, and the individual perish.

When the evil effects of chloroform are concentrated on the medulla, the breathing either stops abruptly or is performed in a shallow, gasping manner; the face becomes livid; the pulse is scarcely perceptible; the pupils are widely dilated, and death follows from asphyxia. When death ensues from syncope, the action of the anæsthetic is expended on the cardiac ganglia. The heart ceases to beat; a death-like pallor overspreads the face, and the respiration, which may continue in gasps for a short time after the circulation stops, is soon arrested. In many instances these fatal cases can be referred to a fatty condition of the heart, or to carelessness in the exhibition of the chloroform, in not observing the first signals of danger, or in a too rigid exclusion of air. Yet in other cases the fatal result is so sudden, and takes place so early in the inhalation, that no explanation is possible, either on the ground of structural alteration in the internal organs, or on that of recklessness on the part of the administrator. It would appear that death may occasionally occur from irritability of the stomach, the poisonous effects being manifested by persistent vomiting, most probably due to the action of the anæsthetic on those ganglionic masses of neurine related to the pneumogastric nerves.

The treatment necessary to meet these poisonous effects of chloroform must be prompt. The anæsthetic must be immediately withdrawn, and the head lowered below the plane of the body, even suspending the patient, if necessary, by the heels. The tongue must be strongly dragged forward out of the mouth by a tenaculum, in order to admit air into the larynx; and, with a view to stimulate the respiratory function, ammonia may be held to the nose. Air must be freely admitted into the apartment by raising the windows or by opening the doors. The surface of the face and thorax must also be flagellated with a wet towel, or dashed with water, thus acting on the cutaneous nerves of the parts, which are all exciters of the respiratory movements of the chest.

If these measures fail to sustain breathing, artificial respiration must be practiced, by compressing the walls of the thorax, or by rolling the patient alternately upon his side and back. A catheter may, for the same purpose, be conducted into the larynx, and air forced into the lungs by blowing through the canal of the instrument with the mouth. In the absence of any tube, the same object may be accomplished by pressing the larynx against the spine so as to close the œsophagus and direct the air into the lungs, and then blowing directly into the patient's mouth.

If an electric battery is at hand, a current should be passed in the direction of the phrenic nerves and from the spine over the walls of the thorax. In addition to these measures, hypodermic injections of brandy may be employed; and, if the sphincter is in a condition to guard the rectum, stimulants may also be thrown into the bowels.

Baillie has suggested, in cases of anæsthetic syncope or asphyxia, the introduction of ice into the rectum. Nitrite of amyl has been employed

in three cases of chloroform-poisoning, and apparently with success.* This agent was dropped in some lint and held to the nostrils until the characteristic flushing of the face appeared, after which the pulse, which had ceased to beat, again returned to the wrist.

The injection of ammonia into the venous system has also been suggested by Mr. Fitzgerald, of Melbourne.

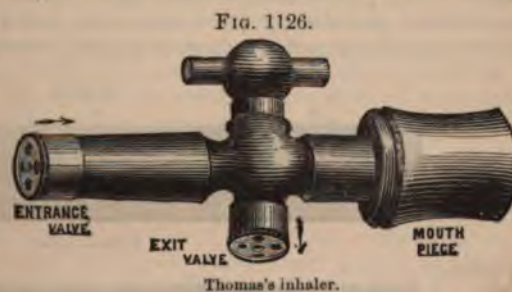
Bichloride of Methylene.—This agent, first suggested for anæsthetic purposes by Dr. Richardson, has been used to a considerable extent in certain London ophthalmic hospitals, as at the Moorfields, and also at the Samaritan Free Hospital. In the former institution I witnessed its exhibition with considerable interest, the anæsthetic effect being induced in three or four minutes, and recovery taking place with equal rapidity. It has been used by Mr. Morgan† eighteen hundred times in persons of different ages, some of whom were kept under its influence for a period of three-quarters of an hour and without evil effects. This agent is also strongly recommended by Mr. J. Spencer Wells. Several deaths by syncope, however, have occurred from its use, which, with the great care necessary to be observed in its employment, have shaken the confidence of some of its early friends as to its value.

Ethidene.—This agent, first used as an anæsthetic by Dr. Snow, and which is procured from aldehyde, gives promise of being both a safe and an efficient anæsthetic. It can be administered in the same manner as ether. It is yet too soon to speak very definitely of its claims to professional confidence. So far as it has been tested, it appears to possess almost the safety of ether, and is at the same time more agreeable to the patient, more rapid in its action, and followed by more speedy recovery. It is occasionally succeeded by vomiting, though not more frequently than chloroform.

Nitrous Oxide.—This agent has many advantages as an anæsthetic. It is absolutely safe, produces its effect quickly, is followed by almost instant recovery, and leaves neither nausea nor headache. Dr. Thomas, of Philadelphia, has administered nitrous oxide over eighty-five thousand times without a single accident. Its inapplicability, however, to purposes of general surgery is quite obvious, as its effects could not be maintained with safety in a case requiring a protracted operation. For the extraction of teeth, the opening of abscesses, the cutting of a fistula, or in performing a tenotomy, the gas can be employed with entire success.

The apparatus required for its administration consists of a large rubber bag or reservoir, connecting with a flexible tube, to which is attached an inhaler, the best being that of Dr. Thomas, of Philadelphia. (Fig. 1126.)

This inhaler is constructed of vulcanized rubber; its canal is half an inch in diameter; it has at one extremity an inhaling valve, and at the other a mouth-piece, its entire length being about eight inches. In the centre is fitted a stop-cock having a second inhaling valve. These valves should be perfectly air-tight, in order that the gas can be administered without any admixture of atmospheric air, otherwise the time required to produce anæsthesia is unnecessarily prolonged, and the sensations experienced during the exhibi-



* British Medical Journal, August 18, 1877.

† Ibid., January 4, 1879.

tion of the gas very unpleasant. Dr. Thomas objects to inhalers provided with hoods which cover in the mouth, except in cases of hare-lip, or where the jaws are stiff, rendering it impossible to pass the mouth-piece between the teeth. These hoods conceal the lips, which should be open to inspection, as the administrator is governed, in the use of the gas, very much by their color.

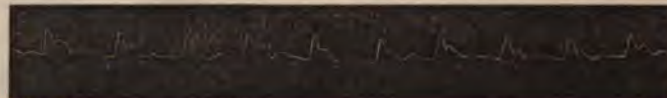
During the administration of nitrous oxide gas the patient should be either recumbent or semi-recumbent. The mouth-piece is placed between the teeth at the end of an expiration, when the stop-cock is turned, opening a communication between the reservoir containing the gas and the inhaler. At each inspiration the nitrous oxide is drawn into the lungs, and during expiration the air escapes through the exit valve of the stop-cock. One minute is usually sufficient to induce anæsthesia. Should any symptoms of syncope appear, the tongue must be drawn forward, the head lowered, and fresh air freely admitted.

Respiratory Anæsthesia.—Dr. Bonwill, a dentist, of Philadelphia, has called the attention of the profession to a mode of producing anæsthesia by *rapid breathing*. The plan has been tested by Dr. Hewson and others, of this city, but in most experiments, I believe, with a negative result.

Comparison of Anæsthetics.—Nitrous oxide, in consequence of the asphyxiated state which it induces, though perfectly safe for operations which can be consummated in a few seconds or minutes, and therefore particularly well adapted to the wants of the dentist, is quite unsuited to the purposes of general surgery. And ethidene being yet on trial, it is only necessary at present to contrast the two anæsthetics now in common use, viz., ether and chloroform.

Chloroform, since it causes less irritation of the respiratory organs, is certainly more pleasant than ether. Its anæsthetic effects are very quickly induced, and the patient is not quite so prone to suffer from subsequent nausea and vomiting. But, with all these advantages, it cannot be denied that chloroform is a much more dangerous anæsthetic than ether. It exercises a pernicious influence on both the respiratory and the cardiac centres, while ether, on the contrary, increases the power of the heart. The experiments of the committee appointed by the British Medical Association have very clearly established these points.* A number of sphygmographic observations taken by Dr. Hand, at my request, on patients in the Pennsylvania Hospital, the results of which are shown in the following diagrams, establish very conclusively the relative influence of ether and of chloroform upon the heart. The pulse-tracings were taken before commencing to administer the anæsthetic, and during full anæsthesia, and in persons whose age and constitutional characteristics bore a general correspondence.

ETHER.



Normal pulse.



Full anæsthesia.

* British Medical Journal, January 4, 1879.

CHLOROFORM.



Normal pulse.



Full anæsthesia.

It will be seen, by following the above registrations, that the tidal and the percussion waves of the normal pulse in the two classes of persons who were the subjects of these experiments are very much alike. During the period of rigidity the tension of the ether-pulse was increased, while that of the chloroform-pulse was diminished. When full anæsthesia was reached, the percussion wave, and, of course, the arterial tension, representing the power of the heart, was greater than the normal in the patient under the influence of ether; while in the case of the chloroformed patient the tracings indicate so serious a loss of power in the central organ of the circulation that one might say to the patient, "As thy soul liveth, there was but one step between thee and death."

But it is not necessary to adduce experiments like the above, evincing the greater safety of ether over chloroform as an anæsthetic. We need only follow the cases of death arising from the use of chloroform and recorded from time to time in the various medical journals. Up to 1869 there had been reported 210 deaths from chloroform. Dr. Baum, of this city, at my request, has carried the record from 1869 to 1872, collecting 195 deaths from the same agent, making 405 fatal results of chloroform-poisoning. During the same period of time not more than 6 instances of death have been imputed to the use of ether, and in 3 of these the anæsthetic employed was a mixture of chloroform and ether, a fact which should entirely exclude them from the computation, as the *a priori* inference is that the ether had nothing to do with the fatal result. Now, if to these 405 deaths from chloroform were added those which have never reached the publicity of the journals (and I doubt not almost every surgeon knows of such), the number would probably be swelled to at least half as many more.

It seems to me that a surgeon who, in the face of such evidence, will continue to employ chloroform, assumes a tremendous responsibility. I hold that where two agents are open to choice, both capable of suspending sensibility and voluntary motion, we are bound, in justice to our patients, to select the safer. No man has any right to jeopardize unnecessarily the life of a fellow-being. Chloroform, except in the few cases where ether fails to produce decided anæsthesia, should be banished from surgical practice.

Local Anæsthetics.

There are a number of agents possessing the anæsthetic power when *locally* applied. Some of these destroy the sensibility by the rapid production of cold, and others by being absorbed and thus temporarily paralyzing the integumental nerves. Among the first-named class may be mentioned

The Frigorific Mixture.—This mixture, recommended by Mr. Arnott, of London, consists of two parts of ice and one of salt. These materials are to be pulverized separately in a canvas or a linen bag, and, after being thoroughly mixed together by a spatula or a knife, must be surrounded by a piece of gauze, which, after one or two minutes, or as soon as the mixture begins to melt, is to be placed over the part to be anæsthetized.

A chilly sensation is quickly felt at the place of contact with the mixture, soon followed by pallor and diminished sensibility. To these symptoms succeed a shriveled and, finally, a hard or congealed state of the skin, the part being destitute of feeling. Fifteen or twenty minutes will be necessary to induce complete anæsthesia of the part.

The effect, however, is transient, and does not extend beyond the integument. So that, except for opening abscesses or exposing a small cyst, it possesses no peculiar merits as a surgical resource.

In operations of a very trifling nature, such as the prick of a hypodermic needle or the opening of a mature abscess (quite sufficient to awaken fear in many sensitive people), the skin may be sufficiently benumbed for the time by simply inclosing a lump of ice in a piece of tarlatan and holding it for a few moments against the surface to be punctured.

Ether, used in the form of spray and directed upon the skin by means



of an atomizer (Fig. 1127), was suggested by Dr. Richardson, of London, as a valuable local anæsthetic. The rapidity with which this material evaporates causes intense cold and rapid freezing of the part against which it is applied. Dr. Richardson, in one instance, excised, under ether spray, a scirrhus mammary gland from a female without any complaint on the part of the patient. Except, however, in operations of a very transient nature, its local application

for purposes of general surgery is very limited indeed.

Rhigolene, one of the products from coal-oil distillation, is another agent used to produce local insensibility, and was proposed for this purpose by Professor Bigelow, of Boston, in 1846. This substance is the lightest of liquids, highly inflammable, boiling at 70° , and, consequently, should be kept in a cool place and handled with great care. Its extreme volatility and rapid evaporation render it peculiarly well adapted for the rapid destruction of sensibility in a part, the evaporation producing a temperature of 15° below zero. Rhigolene is used for anæsthetic purposes from a spray-bottle, in the same manner as ether. One or two minutes suffice for freezing the surface upon which it is directed. For slight operations I have been in the habit of using this article for several years, and with great satisfaction.

Carbolic Acid, though at first causing irritation and pain when applied to the skin, soon produces a complete suspension of sensibility. If it is desired to benumb a part with this agent before making an incision, the acid may be brushed over the surface with a camel's-hair pencil.

CHAPTER XX.

AMPUTATION.

THE term *amputation*, at the present time, is restricted to the operation of cutting off any part or the whole of a limb, and to the removal of the penis. The extirpation of the jaw or the mammary gland, formerly included in the idea of an amputation, is now more properly expressed by the term *excision*.

The possibility of such a surgical operation being done, without fatally compromising the life of the whole body, was probably first suggested by what must have been often witnessed in the infancy of surgery,—the spontaneous separation of a portion of a crushed or mortified limb.

The necessity for amputation has been very much lessened in the last thirty years by the growing importance of conservative surgery,—a progress founded on a higher estimate of the natural recuperative powers of the human body, on improved modes of managing surgical injuries, and on the greater prominence given to excisions in the continuity or the contiguity of bones.

Circumstances demanding Amputation.

In general it may be said that amputation is proper whenever the injury or the disease of a part is such as to render it highly probable that without the operation the limb must be lost, or when the patient's life would be subjected to greater risk by the adoption of any other treatment, such as resection or expectancy. That persons recover occasionally from wounds of the most extensive and apparently hopeless character without operation is true; but such very exceptional cases are not to influence the judgment of the surgeon when deciding upon the propriety of an amputation in any given case. I remember an instance, in the Pennsylvania Hospital, of a patient with a crushed ankle, who obstinately refused to have the part removed, although the indications for the operation were so clear as to admit of no doubt whatever, and yet, after a long and tedious illness, he finally recovered, with a distorted and useless foot. The result, however, was the loss of the lives of three other patients, who, encouraged by the obstinacy of this man, declined operations which, had they been performed, would in all probability have been successful.

It is not simply the preservation of an injured part which should influence the surgeon's decision, but also the probable future condition of that part. A damaged finger may, by an unwise conservatism, be saved, immovably fixed either in a state of extreme extension or flexion; but the hand would have been much better and far more useful had the unfortunate digit been cut off.

The conditions demanding amputation may be included under the following general heads: (1) injuries and diseases of the *soft parts*; (2) injuries and diseases of the *bones*; (3) injuries and diseases of the *joints*; (4) *deformities*; (5) *aneurisms*; (6) *mortification*; (7) *malformations*.

Injuries and Diseases of the Soft Parts.—Under this head will come a certain class of lacerated, contused, and gunshot wounds. When from any cause the soft parts are extensively torn away from the bones, leaving the latter uncovered for many inches in extent, when the muscles are crushed into a pulp, and the principal arteries and nerves severed, rendering it altogether probable that the limb will fall into a state of mortification, amputa-

tion becomes a necessity, and should be done without delay, or as soon as reaction has been established.

Ulcerations.—The soft parts may be attacked by a destructive ulceration, the ravages of which will lay bare the bones and destroy the tissues to an extent which can never be repaired. Amputation, in such a case, will be required.

Malignant growths.—The development of a malignant growth in the upper or the lower extremity, provided the signs of constitutional implication have not become apparent, will constitute a sufficient cause for amputation. This general involvement will be revealed by the enlargement of those lymphatic glands which are directly related to the tumor, by the existence of similar growths in other parts of the body, or by rapid emaciation, loss of strength, and a cachectic expression. Under these circumstances an operation would hasten rather than postpone the fatal event.

When an amputation is performed for a carcinomatous disease, it should be done at a point some distance from the part of the limb involved; for example, when the malignant tumor is situated on the forearm, the knife should be applied above the elbow, or when on the arm, at the shoulder-joint.

Non-malignant tumors may also, on account of the direction of their growth, or from pressure on the chief blood-vessels, endanger the life of a limb. But in such an event, and for a tumor possessing only a local significance, excision of the growth should be substituted for amputation of the limb.

Injuries and Diseases of the Bones.—Under this head may be considered compound and comminuted fractures, caries, necroses, and tumors.

Compound and comminuted fractures.—At one time the existence of a compound fracture, even though of a very simple nature, was sufficient to doom a limb to amputation. The question now, in the light of larger observation and experience, can only be determined by the extent of the injury, by the constitution and habits of the patient, and by surrounding circumstances.

No surgeon would now for one moment contemplate the removal of a limb simply because of the existence of a fracture accompanied with an external wound. When, however, in consequence of a railroad, manufacturing, or mining injury, a bone is broken in one or several places, and the soft parts are lacerated or crushed into a pulp, the blood-vessels and nerves also being torn, the knife is the only alternative. But there are circumstances in which a less mutilation than that depicted above may require the removal of the limb,—in a class of cases well known to military surgeons, in which, on account of the absence of hospital accommodations, surgical appliances, and a sufficient force of medical attendants, or where it is necessary to transport the wounded long distances over rough roads, the prospect of recovery is greatly enhanced by amputation, although the same cases, under more favorable surroundings, or in civil practice, could be saved without the use of the knife.

In like manner, the habits of a patient suffering from a serious fracture of the above description will influence the conduct of the surgeon. A man who has been addicted to alcoholic excesses and other abuses of the system would succumb to an injury of the bones and soft parts from which a younger person would readily recover.

There is occasionally seen, as a result of shot and other contusions, an injury of a very deceptive nature, one in which the skin is not necessarily broken (in consequence of its elasticity and of the bluntness of the vulnerating body), but where the deeper components of the limb, including the bones, may be utterly disorganized, and which is soon followed by mortification. An injury of this kind is disclosed by blebs on the surface of the skin filled with bloody serum, by the boggy feel of the parts, by the absence of the pulse and a loss of temperature, and by the rapid appearance of a purple discoloration. Such are cases requiring amputation. But just where to apply the knife, so as to get beyond the limits of the injured tissue,

is very difficult to determine. It is important, also, in such cases, that the operation be done early. If the surgeon, through indecision, delays interference until the inflammatory swelling and tension of the limb which precede mortification set in, the conditions, as regards the life of the patient, are exceedingly unfavorable for amputation.

The diseases which affect the bones, and which call for the removal of a limb, are caries, necrosis, osteomyelitis, encephaloid and sarcomatous growths, and, occasionally, aneurism, enchondroma, and exostosis. Many cases of caries and necrosis recover without a resort to so radical a measure as cutting off the limb. The employment of a gouge or an acid to remove the disorganized bone, or the extraction of a sequestrum from the medullary cavity, is often quite sufficient to effect a cure. But there are other cases in which the entire thickness of the shaft of a bone for several inches is hopelessly dead, or where the whole carpus or tarsus is included in the caries and nothing short of amputation can offer any prospect of relief to the patient. Ulcers, malignant, syphilitic, and benign, may extend in defiance of all medication, internal or external, and may be attended with such destruction both of the bone and of the superincumbent soft parts that the removal of the limb is absolutely demanded.

Malignant growths which locate themselves in bone do not, as a rule, admit of removal in any manner short of amputation of the limb; and here, as in similar disease of the soft parts, the knife should be applied a sufficient distance above the tumor to be beyond the visible signs of the disease.

Enchondroma and exostosis, in favorable positions, and when the base is not too broad, may be successfully detached by the chisel or the saw without sacrificing the limb.

Injuries and Diseases of the Joints.—*Compound dislocations* constitute a class of injuries which often require amputation, though, in many instances, excision can be substituted, with a fair prospect of preserving the limb. If, however, in addition to the displacement, the soft parts around the articulation are extensively lacerated, or if the principal artery of the limb is torn, as the popliteal, in a compound luxation of the knee, or the brachial, in a similar injury of the elbow-joint, amputation is clearly indicated.

A joint may be extensively comminuted by a conical ball, or by a grape-shot, the lines of fracture extending in one or several directions into the shafts of the bones; and, under these circumstances, amputation becomes necessary.

Compound luxation of the knee-joint—except in certain cases occurring in children—always demands amputation.

Diseases of the joints, whether from strumous or traumatic causes, occasionally call for amputation. The joints most frequently the subjects of scrofulous inflammation are the hip, knee, ankle, elbow, and wrist. The disease may commence in the synovial membrane, or in the cancellated tissue of the articulating ends of the bone, involving, ultimately, all the components of the joint, and terminating in caries or necrosis. The success which has usually attended excision in cases of chronic joint disease has happily narrowed down to a small compass those which require amputation. So that the latter operation, at present, is applicable, for the most part, to cases in which excision has failed, or where, in consequence of profuse suppuration and hectic symptoms, there is a strong presumption that the patient would not endure the exhaustion due to the protracted healing after excision, or where there is a very extensive destruction of the bones beyond the limits of their articulating extremities, by which the limb would be left useless after resection.

As long as there is any prospect of ankylosis taking place in a joint, neither excision nor amputation should be practiced, unless in cases where the local and constitutional irritation incident to suppuration threatens to destroy the life of the patient before the consolidation could be effected.

Deformities.—A limb may become ankylosed in a posture which will render it not only useless, but a serious hindrance to the movements of the patient. A toe or a finger may become immovably flexed, so as to embarrass, in the one case, the prehensile functions of the hand, and, in the other, the use of the foot. When the vicious position cannot be corrected by subcutaneous osteotomy or by excision, amputation is the only resort. There are also deformities resulting from the cicatricial contractions following scalds or burns, from the disability of which the patient can be freed only by amputation.

Aneurism, though generally amenable to pressure or ligation, nevertheless sometimes involves the loss of the limb. Thus, in cases of secondary hemorrhage after ligation of the artery, or in suppuration of the sac, followed by bleeding, amputation above the seat of the ligation is often our only resource.

In connection with the injuries of the blood-vessels may be mentioned shot wounds which sever the chief artery of a limb, as the popliteal or the femoral. Such wounds will in all probability be followed by the death of the limb below the damaged vessel, and will call for immediate amputation.

Mortification is often the result of injuries implicating both the soft parts and the bone. It may also follow the obstruction, embolism, or atheroma of an artery, or the pressure of a tumor, and in military hospitals, where large numbers of injured men are crowded together, *hospital gangrene* may ensue, in consequence of the entrance of septic matters into wounds. By whatever way induced, the destruction may be so extensive as to necessitate the removal of a limb.

Senile gangrene may be regarded as an exception, as this disease does not admit of operative interference.

In general the surgeon, in cases of mortification, is content to wait until the line of demarkation is established before he applies the knife to the limb. There are, however, exceptional cases, and for these and other matter connected with the subject the reader is referred to the remarks on mortification (vol. i. pp. 134, 135).

Malformations.—There are malformations, such as club-foot, which, having been neglected during the early period of life, when such deformities are almost always capable of correction, become finally sources of serious disability, from bursal inflammation and from ulcerations, so that of the two evils amputation is the lesser.

Supernumerary fingers and toes are also proper cases for removal, and the operation may be done with perfect safety at two or three months after birth.

Amputations of expediency should never be undertaken, except under circumstances where the disability is considerable or the peace of mind of the patient is much disturbed.

In addition to the various conditions which have been named as constituting proper subjects for amputation, others have been advocated by writers, such as traumatic tetanus, the bite of venomous serpents and of rabid animals. All such suggestions are chimerical, and, I presume, are at present never seriously entertained by the surgeon.

Period for Amputation.

The time at which amputation can be most advantageously executed in cases of a traumatic kind is a subject of the greatest moment. Writers at present adopt very generally three periods for amputation, or the division introduced by Mr. Alcock, viz., *primary*, *intermediary*, and *secondary*, which answers to the classification of M. Boucher.

Primary.—By the primary period is meant that time which elapses between

the reception of the injury and the commencement of the inflammatory or traumatic fever.

Intermediary applies to the period during which the patient is suffering from the inflammatory or infective fever incident to the local damage.

Secondary.—This period commences with the subsidence of the constitutional disturbance and acute local symptoms and the commencement of suppuration.

The limits of the primary period may be placed somewhere between five and thirty hours. Mr. Skey was disposed to extend the time to thirty-six or even forty-eight hours,—a latitude rather too broad, though I believe admissible in some cases of tardy reaction.

The primary period is almost universally accepted by surgeons—both civil and military—as that in which amputations can be done with the greatest prospect of success. There are many reasons for this opinion. (1) The *morale* of a patient who has encountered some injury which requires the removal of a limb is better shortly after the accident, when the parts are measurably devoid of sensibility, owing to the damage sustained by the nerves, along with the other components of the limb. (2) The general sensibility of the system is lowered by the effects of the shock. (3) During the period between inflammatory reaction and its termination in suppuration the life of the patient is jeopardized by many dangers, such as erysipelas, pyæmia, mortification, and hemorrhage.

Nor is every part of the primary period suited for operation. This period includes both a state of shock and a state of reaction. It is the degree of shock which determines the duration of the primary period, and as long, therefore, as the patient remains cold, pallid, and almost pulseless, and covered with a clammy perspiration, no operation should be attempted. The auspicious moment for the knife has arrived whenever *reaction* has been fairly established.

There is a class of cases in which reaction takes place very slowly, and in which the patient will have passed into the intermediary period before it is fully established. Rather than allow the case to run the numerous risks which endanger life before the secondary period is reached, it is better, provided the operation is not one of great magnitude, or one requiring a long time for its execution, to proceed to its performance, even though the reaction be imperfect.

The *intermediary period* is characterized by both the local and constitutional signs of inflammation. The limb becomes red, swollen, and sensitive; a bloody serum flows from the wound, and the devitalized portions of the latter begin to soften and separate. In addition to these symptoms, there will be an acceleration of the pulse, a hot, dry skin, persistent thirst, scanty urine, coated tongue, headache, nausea, and often some degree of mental wandering.

This period is extremely ill adapted for amputation, which should never be undertaken at this time except under the most compulsory circumstances. If to tie an inflamed hemorrhoid, or to excise an inflamed tonsil, is deemed reprehensible surgery, when most probably the vascular excitement is wholly local, how vastly greater must be the risk to life when an operation of the magnitude of an amputation is performed with the tissues of the limb hot, tense, swollen, and infiltrated with inflammatory products, and the whole mass of the blood aflame under the stimulus of tissue-metamorphosis! Nor are these apprehensions only matters of speculation. On the contrary, experience has amply confirmed their reality. (See vol. i. p. 246.) It is, therefore, entirely consistent with the soundest maxims of surgery, that when from any cause the patient has passed the primary period and entered the intermediary, the operation should be postponed until the inflammatory or infective fever has passed over and suppuration has commenced,—a period which varies from two to three weeks.

The *secondary period* is the calm which succeeds the storm. It is introduced by the subsidence of fever. The pulse becomes soft and less frequent. The

skin, which was hot and dry, becomes moist, and thirst abates. The tongue cleans off, and the intestinal, urinary, and other secretions assume a natural appearance. The desire for food returns, and the patient's cheerfulness is restored. The wound and the adjacent parts assume a new appearance,—the local redness, tenderness, and swelling disappear, the discharge (at first a bloody serum) is replaced by a healthy pus, shreds of dead tissue have been detached, and healthy granulations make their appearance.

And now has arrived that stage which, in its suitability for amputation, ranks next in value to the primary period. Indeed, in not a few instances it possesses advantages superior to the primary. It is a matter of common observation among surgeons that a patient who has been for weeks or months the subject of chronic disease, attended with suppuration and a moderate degree of constitutional disturbance, enjoys a sort of immunity from the usual accidents following operations, and makes a rapid convalescence.

History of Amputation.

It is very difficult to realize that an operation so simple as that of amputation required over two thousand years to bring it to its present perfection. In accounting for this, two difficulties seem to have been conspicuous,—the one anatomical and the other mechanical. The anatomical difficulty consisted in not understanding the circulation of the blood and in the consequent inability to control hemorrhage; and the mechanical perplexity arose from the want of sufficient ingenuity to construct a flap which would cover the end of the stump. From Hippocrates till the time of Celsus, the surgeon simply followed in the wake of nature, never venturing to apply the knife for the removal of a limb, except within the limits of the mortified tissues; and this rule seems to have prevailed for at least four hundred years.

Celsus, the prince of Greek physicians, who lived about or shortly after the time of Christ, and who appears to have been a theological polemic as well as physician and surgeon, introduced the first innovation, by directing that the incision should be made *between* the living and the dead tissues and carried down to the bone. In order that the soft parts might be drawn to some extent over the stump, he also directed that, before the bone was severed, it should be partially separated from the soft parts, so that the saw could be applied at a point higher up. His details of the operation extend also to removing from the bone any asperities which might be left by the saw. It would seem, from the boldness of this procedure, that the use of the ligature as a means of controlling hemorrhage was known to Celsus; and this is rendered probable by the allusions which he makes when treating of wounds, to "seizing the bleeding vessel and tying it in two places," and to a passage in Cocchius, who speaks of "stitching" bleeding vessels.

Whether from these passages we are to infer that the ligature was applied to the arteries during amputation, or only in wounds of a different kind, has been a subject of considerable discussion. Admitting that the thread was used at all, it seems quite probable that its application would be more strongly suggested after amputation than in any other wound, as nothing could be more natural than to seize and tie a spouting vessel, even though the operator might know nothing about the order of the circulation. Granting, however, that ligation was practiced by the disciples of Celsus, much blood must necessarily have been lost during the removal of a limb. This difficulty was in some measure provided for by Archigenes, a Syrian, who practiced his profession in Rome during the reign of the Emperor Trajan, and, consequently, not long after the time of Celsus. This surgeon surrounded the limb above the seat of amputation with a cord or band, drawing it sufficiently tight to lessen the effusion of blood while the incisions were being made. To diminish the bleeding still further, he applied cold water to the entire limb. Archigenes's attempt was the earliest in the construction of a tourniquet. He does not appear, however, to have followed the precepts of

Celsus, in respect either to hemorrhage (by tying the vessels) or to separating the soft parts from the bone and dividing the latter high up, so as to procure a covering for the stump. He controlled hemorrhage by the use of a hot iron, and had the soft parts well drawn up before their division, so as to secure the necessary flaps.

For a long period after this the surgery of amputation appears to have retrograded. Galen, who, through his native timidity or his reverence for ancient authority, ruled the profession as with a rod of iron for fourteen centuries, inculcated the Hippocratic doctrine of confining the incisions to the dead tissues and treating those portions nearest to the living flesh with the actual cautery.

The Arabians followed the teachings of the Greeks. Thus, we find Paulus Aegineta and Avicenna advising the division only within the mortified parts. Albucasis, with more boldness than his contemporaries, approached the sound tissues, using, in order to prevent hemorrhage, a red-hot knife for dividing the soft parts. During the long period which succeeded the fall of the Roman Empire—the mediæval ages—medicine and surgery made no progress. The cloister became the depository of what little learning remained, and the clergy employed the resources of surgery more for their personal distinction than from any scientific zeal. Indeed, some of the edicts which were promulgated by “the spiritual head of the Church,” as that of Boniface VIII., rendering it unlawful for the clergy to engage in anything which was connected with the shedding of blood, were calculated to prevent any improvement whatever in the surgical branch of medicine.

In consequence of the introduction of gunpowder, in the fourteenth century, war became more destructive. It is impossible to conceive of the dreadful suffering and loss of life following the sanguinary conflicts of this period in consequence of the degradation to which surgery had been consigned. It was towards the close of the Middle Ages that Gui de Chauliac devised the plan of bloodless amputations, by first enveloping the limb in a thick coating of pitch and then encircling the member at one of its articulations with a cord, which was tightened to a degree which insured the mortification of the parts below the seat of constriction.

When the long night of ignorance and barbarism began to disappear in the latter part of the fourteenth and the beginning of the fifteenth century, medicine, in common with letters in general, was transfused with new life. Anatomy, the only true basis of surgery, made singularly rapid progress. At this epoch appear the distinguished names of Vesalius, Fallopius, Eustachius, and others familiar to the student of medicine; but, with all the achievements of these eminent scholars, the problem of controlling hemorrhage remained unsolved. Thus, we find Fabricius ab Acquapendente and Fabricius Hildanus advocating the cautery as the great hæmostatic. The last-named surgeon, in the early part of his career, used the red-hot knife for the purpose of dividing the tissues and at the same time searing the blood-vessels.

As late as the middle of the seventeenth century limbs were removed by the chisel and mallet. As celerity of operation was deemed a vital matter, in consequence of the loss of blood, it was during this period that Botalli invented his guillotine, consisting of a sharp, heavy axe, which, being allowed to fall from a height upon the limb, severed it instantaneously at a single blow. At the time of Richard Wiseman, the common mode of amputation was first to encircle the limb tightly with a cord, for the double object of preventing hemorrhage and of benumbing the limb. The integuments were next drawn strongly upward by an assistant, after the manner of Celsus and Archigenes, so as to procure material for a flap with which to cover the stump. A knife was then carried swiftly around the limb, dividing the soft parts to the bone, after which the latter was cut through with a saw, and the bleeding controlled by the hot iron.

It was about the year 1579, or in the last quarter of the sixteenth century, that Ambrose Paré discovered or revived the use of the ligature for the arrest

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of bleeding in amputation. In removing a limb this surgeon forcibly retracted the soft parts, and retained them so with a bandage drawn strongly about the member. This bandage fulfilled a threefold purpose, namely, the retention in place of the retracted soft parts, the compression of the blood-vessels, and the diminution of sensibility by pressure of the subjacent nerves. The knife was next applied to the skin immediately below the fillet or band, and carried down to the bone; and when the operation was performed on the leg or the forearm, the interosseous structures were divided with a smaller knife. This done, the bones were cut through with a saw at as high a level as possible, and the arteries drawn out with forceps (including, in some instances, the surrounding tissues), and each tied with a double ligature. The vessels having been secured, the band was next detached from the limb, the soft parts drawn down over the wound, their edges drawn towards each other, and so maintained by the sutures.

The ligature, therefore, used by Paré, had it been accepted by his contemporaries, would at once have rendered unnecessary the formidable cauterizing irons, with all the evil consequences attending their use. Instead, however, of this being the case, not only was it repudiated by Paré himself, but it was subjected to abuse without measure, so that almost a century elapsed before the ligature was employed in France for the arrest of hemorrhage, chiefly through the advocacy of Dionis.

The first part of the seventeenth century was made forever memorable by the discovery of the circulation of the blood by Harvey. Like the ligature of Paré, the public announcement of the movement of the heart and blood, which was made in 1628, subjected its author for a time to ridicule and abuse, which ceased only when the demonstration of the discovery became fortified by an invincible accumulation of facts.

A natural result of the discovery of the circulation was the invention, in 1674, of the *tourniquet*, by Morel, a French surgeon. It was devised during the siege of Besançon, and may therefore be justly credited to military surgery. The instrument consisted of a band, which was placed around the limb and tightened by passing underneath it a stick and turning the latter until the necessary degree of constriction was obtained. This rude contrivance no doubt suggested the instrument devised by Petit, another French surgeon, forty-four years later (in 1718), which is essentially the *tourniquet* in common use at the present day. It is remarkable how this old instrument, with its acknowledged defects, has so stubbornly retained its popularity in defiance of many substitutes which have been invented.

The example of Dionis in France, in regard to the use of the ligature, was followed in England by Richard Wiseman, and in Germany by Hildanus.

Two great achievements, however slow in being attained, had at length been accomplished,—the control of hemorrhage during the process of an amputation by the *tourniquet*, and the closure of the vessels after the operation by the *ligature*.

The operation, nevertheless, was still very imperfect, in that surgeons had as yet not been able to construct a covering for the stump. And this brings us to speak of the different methods of amputation.

Various Methods of Amputation.

However various the plans of amputation, they may all be embraced under two general heads,—the *tegumentary* and the *musculo-tegumentary*.

Tegumentary Method.—This method is executed in two ways,—by a *circular flap* or by *oval flaps*.

CIRCULAR TEGUMENTARY FLAPS.—Amputation by this method may be divided into three stages,—the division of the integument, the division of the muscles, and the division of the bones. *First*, the surgeon, standing on the outside of the member to be removed, provided he be ambidexter, and stooping

down, passes his hand beneath and around the limb, holding the knife lightly between the thumb and the index and middle fingers of the hand, and applying the middle of the blade to that surface of the limb which looks towards the operator. (Fig. 1128.) The instrument is now carried rapidly round the member, ending with the heel of the knife at the point of beginning, and dividing perpendicularly the skin and superficial fascia down to the deep fascia. Any points where this is not effected can be readily incised by a few touches with the edge of the instrument. It is sometimes advised that the operator, previous to and while making the circular division of the integument, should draw the latter upward with the other hand. This preliminary measure is a matter of personal preference, and may or may not be adopted, according to the pleasure of the operator, as it possesses no special advantages in this method of amputation. The division of the integument is promptly followed by its retraction, leaving a considerable gap between the two sides of the wound. A gush of venous blood also occurs at the moment the skin is cut through; but this ceases as soon as the engorged trunks are unloaded.

The integument is next dissected up from the deep fascia and reflected, as one rolls back the cuff of his coat-sleeve. (Fig. 1129.) This is done either with the point of the amputating-knife, or with the scalpel, and to an extent greater than is necessary to cover the raw surface of the stump. In raising the integument, the edge of the knife must be directed against the deep fascia, so as to include all the subcutaneous adipose tissue in the flap. The exact amount of this flap must be determined by the eye of the surgeon, as it is both awkward and inartistic to be compelled to resort to measurements. If the limb at the place of operation measures twelve inches, its diameter will be four inches, and a flap two and a half inches on each side will be required.

Second.—The integument being now reverted and held out of the way by the operator or his assistant, the knife is applied to the limb on a level with the base of the reflected integument, and made to divide the deep fascia and muscles down to the bone, with the same circular sweep as in the first incision. If the amputation is being done on the leg or the forearm, the next step consists in passing a narrow catling between the two bones, and, after dividing the interosseous structures, carrying the instrument around each bone separately, so as to sever all its connections with the soft parts and the periosteum.

This done, the middle strip of a three-tailed retractor is pushed with the finger or the forceps through the interosseous space, the other strips being crossed, and all three gathered together and drawn up on one side of the wound, while the undivided end of the retractor is pulled up on the other side and both ends intrusted to the hand of an assistant, who in this manner holds the soft parts out of the way while the bones are being divided.

FIG. 1128.



Position of the knife in beginning the circular incision.

FIG. 1129.



Circular flap dissected from the deep fascia and reflected.

Third. The third and last stage consists in the division of the bones. This is a part of the operation which requires great care in its execution.

The operator himself, and not an assistant, should always grasp that portion of the limb which is to be removed, with one hand, while he plies the saw with the other. In this way the two hands co-operate in such a manner that the saw does not become locked in the groove made by its teeth, in consequence of the distal part of the limb being raised too much, nor are the fibres of the bone broken without being cut, as would be the case if the amputated portion were permitted to sink prematurely.

No attempt should be made to force the saw into the bone. It should be allowed to cut only by its own weight. And it should be driven by a steady, long, to-and-fro movement. The saw is best used in the *horizontal* position, with a single exception,—that of amputation of the leg, when it can be applied most conveniently between an oblique and a vertical position. It is desirable also here, as in the arm, that both bones should be severed simultaneously; but, if this is not done, the smaller and more movable bone of the two (the fibula) should be first divided, as, by observing this rule, there is less danger of breaking the osseous tissue.

Before sawing the bone, Dr. McGill, U.S.A., has suggested raising two periosteal flaps with which to cover the end of the bone. This has been done in several instances, and with very satisfactory results. It tends to protect the medullary tissue of the bone against the intrusion of inflammatory and other products which might endanger the life of the patient.

When the soft parts are divided by the double incision, the stump will

FIG. 1130.



Appearance of the stump after the usual circular operation.

present very much the appearance represented in Fig. 1130. The different degrees of retraction of the superficial and deep strata of muscles depend on the fact that the former are much more loosely connected with the subjacent parts than the latter.

Modifications of the circular operation.—To provide against the unequal retraction of the muscles and secure a uniform plane to the stump, as well as to save pain, by not raising the integument from the deep fascia, Louis, a French surgeon, practiced a modification of the double incision. After

drawing up the skin and applying a band around the limb immediately above the place where the knife was to be applied, Louis made the first cut through the integument, the deep fascia, and the superficial layer of muscles. That these parts might be allowed to retract to the uttermost, the constricting cord was now removed, and the deep layer divided on a level with the superficial stratum, thus enabling him to cut the bone off high up. Dupuytren was also in the habit of cutting the integuments and superficial layer of muscles at a single incision.

All of these operations, however, very imperfectly fulfilled the great necessity,—that of forming a sufficient covering for the stump. Several names are associated with this last achievement. Those deserving special prominence are Loudham, Cheselden, Alanson, and Petit. The claim of priority appears to belong to Loudham, of Exeter, England. A letter was written to a surgeon in London, Thomas Hobs, in 1678, in which (after describing an operation by which a tegumentary flap taken from the calf of the leg was brought over the surface of the stump and united by sutures to its edge, securing healing, and preventing exfoliation of bone), the writer goes on to say that he had learned the method from Mr. Loudham. This letter was written one hundred and one years before the writings of Alanson, which were published in 1779.

Alanson's plan of dividing the muscles in the form of a hollow cone was, however, an original idea.

Cheselden brought up again what has been improperly called the method of Celsus,—dividing the integument, and, after drawing it up, making a second cut on a level with the retracted skin and cellular tissue down to the bone, in order that the bone might be sawed as high up as possible. But the operation of Cheselden differed from that of Celsus in a very important particular, viz., that not only was the skin divided and drawn up, but it was also dissected loose from its subjacent attachments, which necessarily increased the amount of tegumentary covering. This operation has also been attributed to Petit.

The great tension to which the soft parts were subjected by these plans of operation, in order that they might be brought together over the bone, rendered their union very precarious. And hence conical stumps and the protrusion of bone were very common occurrences. To obviate this, Mr. Alanson devised the plan of cutting the muscular components of the limb (after dissecting up a sufficient amount of integument to cover the end of the stump) so as to form a hollow cone, its apex being upward, and answering to the point where the bone is to be cut off. The operation was applicable only to thigh amputation.

Triple incisions were practiced by Desault and Hey. The first extended through the integument; the second on a level with the retraction of the latter and through the superficial muscles; and the third through the deep layer to the bone, on a plane with the first.

OVAL TEGUMENTARY FLAPS.—An objection which may be urged with considerable force against the ordinary circular operation is the difficulty, or rather impossibility, of folding back or reverting the integument in certain portions of the extremities (as at the middle of the leg or forearm), in consequence of their rapidly increasing size as we ascend. A slit in the integument, on opposite sides, will obviate the difficulty; but these cuts detract from the appearance of the covering. To meet this objection the *oval tegumentary flap* method was introduced by Syme.

This operation is done by making two semilunar incisions on opposite sides of the limb down to the deep fascia, and dissecting up the integument to an extent sufficient to cover the stump. In the forearm, in the leg, and in the thigh the flaps should be raised from the anterior and posterior aspects of the limb; in the arm, from the outer and inner surfaces; and they are occasionally made of unequal lengths,—the longer of the two being turned down or brought up over the end of the bone, according as the circumstances of the case require. In lacerated wounds of the extremity requiring amputation, it may be necessary to form more than two flaps, and often, in similar injuries of the hand, only a single flap can be obtained.

These flaps being reflected, a circular cut is next made through the muscles down to the bone, on a level with the reflected skin and cellular tissue. Or, if the amputation is being done on the thigh or the arm, the two layers of muscles may be divided separately, so as to compensate for their unequal retraction. At the two points where the elliptical incisions join, or at the angles of the wound, the integument should be raised a short distance from the subjacent parts, in order that the bones shall not project at these points after the approximation of the flaps. (Fig. 1131.)

When the forearm or the leg is the part to be removed, the interosseous structures are next to be divided by the catling; or, if the arm or the thigh is the subject of the operation, the knife must be carried round

FIG. 1131.



Oval tegumentary flaps reflected and dissected up at their angles.

the bone. In either case the knife should divide the periosteum, since without this precaution the teeth of the saw are liable to detach that membrane unnecessarily from the bone.

Single tegumentary flap, or the method of Carden.—Mr. Carden, of Worcester, England, in 1846, introduced an operation which possesses a high practical merit in certain localities,—*e.g.*, when it becomes necessary to remove the thigh above the knee. By adopting the plan of this surgeon, a covering can be taken from the front of the joint, by which the amputation can be made through the bases of the condyles instead of through the lower third of the femur,—a matter of vital importance, as it will necessarily diminish the mortality of thigh amputations.

This method consists in raising a long, rounded, anterior flap of integument, without any posterior flap, dividing the remaining soft parts, and, after drawing up the latter, cutting off the bone with the saw. The long, anterior tegumental flap is then brought down over the face of the stump like a hood, without being folded back.

Musculo-Tegumentary Method.—By this plan the flaps are composed of both integument and muscle; in other words, include all the soft parts of the limb. They are sometimes taken from both aspects of the limb (*bi-musculo-tegumentary*), as in amputations of the arm, the forearm, and the thigh, and present, when properly fashioned, an inverted V-shaped figure. Or one flap alone may be *musculo-tegumentary*, and the other *semi-musculo-tegumentary*, as is usually done in amputation at the middle or in the upper third of the leg, the former being constructed from the back, and the latter from the front, of the limb. The flaps may also have a *rectangular* shape.

BI-MUSCULO-TEGUMENTARY FLAP.—There are three modes of performing this operation. In one, the division of the soft parts is made from within outward, after the manner of Vermales, and in the other from without inward,—a plan preferred by Langenbeck; while Luke embodied both methods in his procedure, which consisted in cutting one flap from within outward and the other from without inward. These flaps are not always formed of the same lengths. As a rule, each flap should be equal to at least three-fourths the diameter of the limb.

Operation.—After adopting the necessary precaution against hemorrhage by applying the tourniquet, the integument is drawn well up by an assistant, when the operator, grasping with one hand the soft parts on one or other aspect of the limb, raises them up from the bone, and with the other hand passes a sharp-pointed amputating knife through the base of the mass so raised, from side to side, shaving the bone as the transfixion is made. The knife is now carried downward and forward by a sawing movement, and brought obliquely out on the surface, making a *semi-oval* flap; or, if the surface to be covered is a broad one, by cutting directly downward to the requisite extent and then abruptly outward, forming a *square* flap. After the completion of the first incision, an assistant seizes the flap, and, holding it out of the way, compresses with his fingers any vessels of magnitude that may be bleeding.

The surgeon now enters his knife at the angle of the wound on one side, and brings it out at a similar point on the other side, passing across that aspect of the bone opposite to the first transfixion, and cutting downward and outward by the same movement of the knife as was practiced in making the first flap. The appearance of the wound after the completion of these incisions is represented in Fig. 1132. In forming these musculo-tegumentary flaps, the one which contains the chief vessels of the limb should be divided last, so that as little blood as possible may be lost should the circulation through the limb not have been thoroughly controlled by the tourniquet.

In transfixion, it is important that the knife be carried steadily through from side to side, without being withdrawn and again advanced, as is sometimes done when the point becomes arrested against the bone. The blade

should be made to glide over the latter by altering the position of the handle. For if it be drawn back and again thrust onward, a second wound is inflicted, which may involve a considerable vessel, or may wound the same vessel in a second place, and thus give rise to a troublesome bleeding.

The flaps being now held back, the knife is quickly carried around the bone at the apex of the wound, in order to divide any remaining portions of the muscular tissue which may have escaped the first incisions, and also to cut through the periosteum. As the flaps can be readily drawn back by the hands of an assistant, the retractor is not necessary for their protection, and the saw can at once be applied to the bone.

When the incisions are made from without inward, the knife divides first the skin, and is carried upward and inward, or in directly the reverse direction of the operation by transfixion.

AUTHOR'S MODIFICATION.—As, after division of the soft parts by transfixion, the skin is found to retract much more than the muscles, leaving the latter hanging some distance below, I have been in the habit, in order to avoid this inconvenience, of first raising two elliptical tegumentary flaps for a little distance, and then pushing the knife at the angles of the wound between the muscles and the bones, and cutting downward and outward, first on one side and then on the other, terminating the incisions at the line where the tegumentary flaps are attached. (Fig. 1133.) When the latter are reverted, the skin and muscles will be found to be of the same length.

The Oval Method, so termed by Scoutetten, is a bi-musculo-tegumentary operation, which is chiefly applicable to amputation at certain articulations, as those of the metacarpo- or metatarso-phalangeal joints, and also at the shoulder. The flaps are usually formed by cutting from without inward, or one may be fashioned in this way and the other from within outward.

In case of a metacarpo-phalangeal articulation, the point of the knife is applied usually a little above the joint, and, after being pushed down to the bone, is carried downward, gradually diverging from the mesial line to one side, and finally terminating at a point on the palmar surface nearly opposite the place of commencement. A similar incision is next made on the opposite side of the articulation, commencing and ending at the first. When completed, the wound presents an oval appearance or resembles somewhat two V's with their bases resting together. The operation is a good one, and the wound is one admitting of a very neat and accurate adjustment.

Semi-Musculo-Tegumentary Method.—This operation consists in forming

FIG. 1132.



Appearance of the wound after the formation of the bi-musculo-tegumentary flaps.

FIG. 1133.



Author's modification of the flap method. Skin raised and reflected and muscles transfixed. The dotted line indicates where the muscles are to be cut out. Above, skin and muscle, both reverted.

from one aspect of the limb a musculo-tegumentary flap, and from the other a tegumentary flap.

The plan is well adapted to amputation through the middle or upper portion of the leg, the calf of the limb furnishing abundance of material for the construction of the musculo-tegumentary covering, and the anterior surface supplying the tegumentary flap. (Fig. 1134.)

FIG. 1134.



Semi-musculo-tegumentary flap.

Quadrangular Musculo-Tegumentary Method.—This method has been practiced in two ways,—the one known as that of Ravaton, the other that of Teale.

Ravaton's plan (1739) consisted in first making a circular incision through all the soft parts down to the bone, and next two vertical cuts leading directly up from the first, one on either side, and extending also as deep as the bone. The two symmetrical flaps were next dissected up, reflected, and the bone sawed off on a line with their reflection.

Teale's plan (1855) differs from Ravaton's chiefly in the flaps being of unequal length, one long and the other short. The first was planned so as to contain the principal blood-vessels and nerves. The second, or long flap, was employed to cover the end of the bone. The rule for forming these flaps was as follows: the long one, which should be first cut, must equal in length one-half the circumference of the limb at the seat of operation, while the short flap is required to be one-fourth the length of the long one, or one-eighth the circumference of the limb. It is usual, before cutting these flaps, to trace the lines of incision with ink, with a view to secure greater accuracy in their construction. (Fig.

FIG. 1135.



Lines of incision in Teale's rectangular amputation.

1135.) After dissecting up and reverting the flaps, the bone is to be sawed off, and, after the ligation of the vessels, covered, by bringing over its extremity the long flap, the end of which is to be attached by sutures to the end of the short one. The sides of the two flaps are also to be connected by sutures, as well as the contiguous borders of the long flap to each other. (Fig. 1136.)

Wharton's modification of the rectangular method.—In 1868, Mr. Wharton, of Dublin, suggested a modification of Mr. Teale's rectangular operation, which consisted in forming only a single flap, and sawing off the bone on a level

with what would be the lower portion of the short flap according to the Teale plan. The operation has been favorably spoken of by Maypothor, Macnamara, and other distinguished Irish surgeons.

This is much the same operation as that practiced by Mr. Spence, of Edinburgh, ten years previous.

HISTORY.—About the year 1706, a surgeon of Amsterdam, Verduin, in an amputation of the leg, devised a musculo-tegumentary flap which he took from the calf of the limb, by passing a knife through from side to side between the gastrocnemius and soleus and the bones, and cutting downward and outward to the surface. The single muscular flap was brought up in front of the stump and firmly pressed against its surface, where it was held by a peculiar instrument, with the double object of securing a covering for the wound and of controlling by pressure the bleeding from the vessels.

In 1750, Garengnot, in an amputation of the arm, formed double musculo-tegumentary flaps by taking one from either side, and, after tying the vessels, placed these flaps over the end of the stump, securing them at the same time with a bandage.

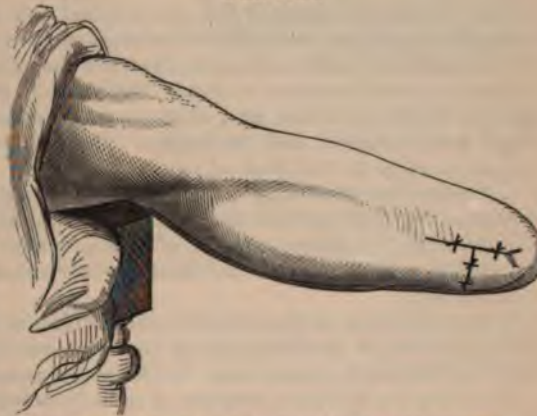
Lastly, Vermale, in 1767, introduced the operation now generally adopted in amputating by the musculo-tegumentary plan, viz., that of pushing the knife through from one side of the limb to the other in close contact with the bone, and, after cutting a flap downward and outward on one aspect of the limb, repeating the same procedure on the other aspect.

Comparison of Methods.—**TEGUMENTARY FLAPS.**—The objections which have been urged against the tegumentary flap are, the time required for its execution, the danger to the vitality of the flap, the difficulty of reverting the latter in some parts of the limb, and the puckered character of the cicatrix. Before the introduction of anæsthetics the first objection was a valid one, as the operation of cutting through the skin and dissecting up and turning back the integument was not only exceedingly painful, but was necessarily the work of some little time. Now, however, the different stages of forming this covering can be executed deliberately, and without the patient's consciousness of any suffering.

The *second* objection, or the danger to the life of the flap, is still valid. The raising of the integument from the deep fascia can only be accomplished by the division of hundreds of vessels, which serve to connect the skin with the subjacent parts, so that the work of nutrition of the flap is entirely dependent on the presence of those arteries which remain intact at the line where the integument is reflected, and which, in long flaps, may prove entirely inadequate to furnish the necessary supply of blood. The plan which I frequently adopt, of raising the integument only for a short distance, and afterwards cutting a muscular flap, diminishes in a great measure the risk from this source. In wounds attended with much contusion tegumentary flaps cannot be regarded as trustworthy.

The *third* objection (the difficulty of reverting the flap where the circumference of the limb rapidly increases from below upward) is one of little force,

FIG. 1136.



Appearance of the flaps when adjusted after Teale's operation.

as it applies only to the circular operation, and even in this is quickly removed by making a vertical slit in one or both sides of the integument.

The *fourth* objection is that which takes exception to the cicatrix. In the circular flap, after union has been completed, the cicatrix contracts to a central point, from which the skin radiates in plicated folds. The intermediate creases or depressions may become chafed by the moisture in hot weather, macerating the skin. A little attention to cleanliness will obviate this when it does occur; and as to central disposition of the cicatrix, I cannot conceive of any reason why it should be more objectionable than a linear one.

The advantages claimed for the method are, that the flaps, containing no muscular tissue, are not liable to become separated after their adjustment by the contraction of the muscles; that, for the same reason, the danger of bone protrusion or of a conical stump is diminished; that deep-seated suppurations are less likely to occur; and that necrosis, neuralgia, and secondary hemorrhage are rendered less probable. These advantages, however, are by no means peculiar to this plan of operation.

MUSCULO-TEGUMENTARY FLAPS.—The advantages claimed for the musculo-tegumentary flap method are, the great rapidity with which it can be performed, and the large cushion of tissue which it furnishes for the end of the stump, which renders the latter better capable of sustaining the weight of the body.

With reference to the celerity with which a limb can be removed by the above method, it has been shown that the question of time is less important now than formerly, when anaesthetics were unknown.

Nor does the massive cushion of muscle remain as a permanent covering for the stump. It gradually becomes atrophied, and finally disappears, leaving only the connective tissue which served to hold together the fasciculi. Even if the muscular tissue did remain, it would prove an evil rather than a benefit, as the persistent contractions of its fibres would finally render the covering of the stump tense, and probably cause its ulceration. Nature does not often err in her plans of repair. Indeed, no cushion is wanted on the ends of a bone, as the mechanic in adapting an artificial substitute for a lost member distributes his pressure over the circumference, not at the end of the limb.

The disadvantages which have been urged against this flap method are, the oblique direction in which the vessels are cut, the risk of secondary hemorrhage and of neuralgia, the great extent of the wound, and, consequently, the delay in healing.

There is some force in the first objection, as the vessel may be shaved or slit for some distance, or it may be wounded in more than one place, and therefore may not be tied above the highest opening. This difficulty is far from being of an insuperable kind, as it will be removed by a little additional care in ligation. It is not true that secondary hemorrhage is more frequent after amputations by the musculo-tegumentary flap than by the tegumentary. Nor is the extent of the wound or the time consumed in healing any greater in the former than in the latter method.

Most of the neuralgic or painful stumps which have come under my observation have been in limbs amputated by the tegumentary method; though I am disposed to believe this troublesome condition was not at all dependent on the mode of operation.

TEALE METHOD.—The plan of forming rectangular flaps is one which, in many instances, will prove satisfactory. But it has disadvantages which will militate against its being generally accepted. Operations requiring for their proper performance preliminary measures and tracings are not likely to become very popular. The extensive division of tissue which is demanded by the Teale method, greater than by either the ordinary tegumentary or the musculo-tegumentary method, protracts the period of healing. In addition to this, there is an unnecessary amount of bone sacrificed.

In illustration of this last fact, let us suppose an amputation of the thigh

becomes necessary from injury or disease of the knee-joint. By Carden's method the limb could most probably be removed at the base of the condyles; by the ordinary musculo-tegumentary flaps, two inches higher; but by the rectangular plan, assuming that the circumference of the thigh would be fourteen inches, the bone would require to be cut seven inches up, which would seriously detract from the leverage of the limb, as well as add to the mortality of the operation. It may be estimated that for every inch lost in the formation of the long flap twice that amount of bone must be sacrificed,—an objection that must weigh heavily against this plan in many cases of lacerated wounds requiring amputation.

CARDEN'S METHOD of *one long integumental flap* has only a local value, namely, in condyloid amputations of the thigh. To extend it beyond this would be to endanger the life of the flap.

CONCLUSION.—When we come to sum up and compare the advantages and disadvantages of the two general methods of amputation, the results are very nearly balanced.

Indeed, no single method can be wisely adopted by a surgeon as applicable to all portions of the extremities. In some localities tegumentary flaps will be found best adapted to cover the stump, while in other parts of a limb the musculo-tegumentary, in some of its modifications, will prove most satisfactory.

At the lower third of the leg, and in the forearm near to the wrist-joint, where tendinous structure predominates, I much prefer a *tegumentary flap*; while in the thigh, at the upper two-thirds of the leg, and in the arm, I often employ the *musculo-tegumentary flap*.

Operation.

Under the head of the operation of amputation we consider the instruments to be used, the position of the patient, the number of assistants necessary, and the dressing of the stump.

INSTRUMENTS.—The instruments and other appliances usually required for the operation are a tourniquet, a large-sized scalpel, a forceps, an amputating knife, a catling, saws, and bone pliers, an artery forceps or a tenaculum, and a retractor, together with sponges, towels, ligatures, needles, lint, and rollers. These implements, etc., should be arranged, previous to the operation, on a tray or waiter, over which has been laid a towel, in order that the edges of the instruments may not be injured. The tourniquet generally employed is that of Petit (Fig. 1137), which has been particularly described in vol. i. (page 161).

The amputating knife varies from seven to thirteen inches in length; its breadth is from three-eighths to half an inch; it should have a stout back, with a strong handle, which, instead of being rough, as it is usually made, should be smooth, in order that no foreign matter may adhere to its surface. (Fig. 1138.) The catling is a double-edged instrument, and, like the amputating knife, varies in length from seven to nine inches. (Fig. 1139.) It is designed to pass between the

FIG. 1137.



bones, in order to divide the interosseous structures, and should never

FIG. 1138.



Three sizes of amputating knives.

exceed three-eighths of an inch in width, as otherwise it cannot be conveniently used.

FIG. 1139.



Long catling.

Short catling.

The two instruments—amputating knife and catling—can, where economy

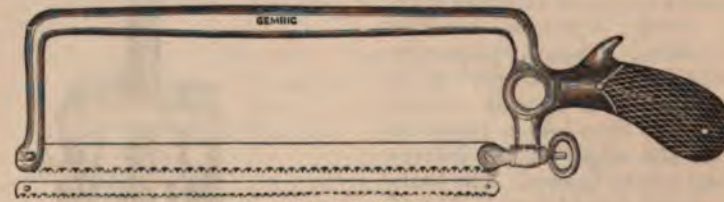
FIG. 1140.



Catling and amputating knife combined.

is an object, be combined in one (Fig. 1140), the double edge being restricted to three inches in length from the extremity of the blade.

FIG. 1141.



Amputating saw.

The saw in common use resembles either the dovetail- or the jig-saw of

FIG. 1142.



Amputating saw.

the carpenter. (Figs. 1141, 1142.) For amputations of the hand or foot,

a smaller saw will be required, the back of which is movable and can be raised from the blade. (Fig. 1143.) The teeth of the saw should be set in such a way that the instrument will cut during both the forward and the backward movement.

FIG. 1143.



Small-sized amputating saws.

The bone pliers are designed to remove any irregularities which may be left by the saw on the end of the bone. (Fig. 1144.)

FIG. 1144.



Bone pliers.

A large-sized scalpel (Fig. 1145), to raise the integument when forming skin flaps, a pair of forceps and a tenaculum, to seize and draw out the ves-

FIG. 1145.



Scalpel.

sels for ligation, conclude the summary of the instruments required for an amputation.

FIG. 1146.



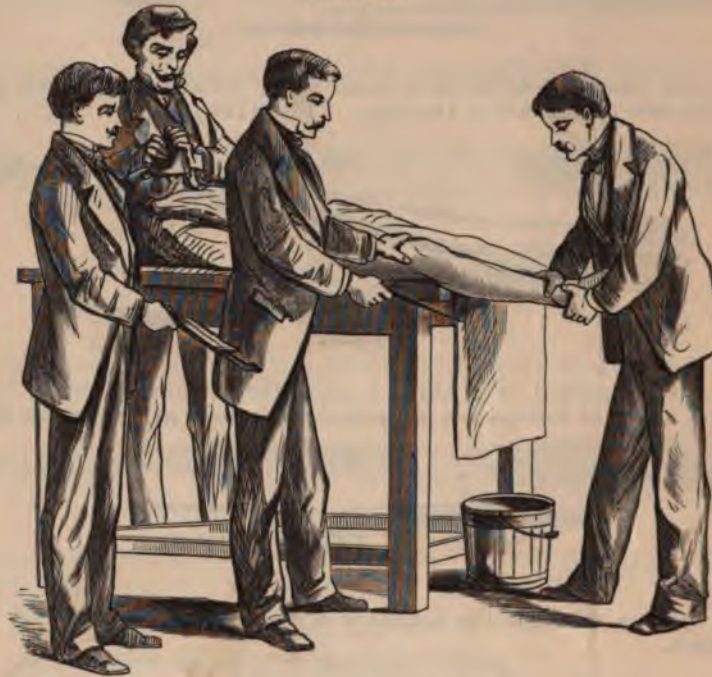
Amputating case.

An amputating case, with its contents, is very well represented in Fig. 1146.

Position of the patient.—The patient must be placed in the recumbent position, on a firm table covered with a mattress or with some folded comfortables and protected by a gum- or oil-cloth; or, if a table is not convenient, on a bed, with the limb to be removed projecting from its side.

Assistants.—The number of assistants that can be employed with advantage in major amputations is three, distributed as follows: one to administer the anæsthetic, one to support the limb, and one to hand and receive instruments; the latter can also assist in the ligation of the arteries. These are to be disposed in such a manner as not to interfere with one another. (Fig. 1147.)

FIG. 1147.



Disposition of surgeon and assistants in performing an amputation.

CONTROLLING THE CIRCULATION.—Two or three turns of a bandage being passed loosely around the limb, the body of the roller, acting as a compress, should be placed longitudinally over the principal artery, and upon it the base of the tourniquet is adjusted, and the strap of the instrument buckled around the limb. Before tightening the tourniquet, the parts should be emptied of blood as much as possible, by elevating the extremity and compressing the artery with the thumbs at a point where the circulation can be most easily controlled, as against the horizontal ramus of the pubic bone in leg or thigh amputations, along the inner edge of the biceps muscle in forearm and arm amputations, or, when the operation is demanded near the shoulder, by pressing the subclavian artery against the first rib above the clavicle. As this pressure, when applied accurately on the vessel, does not interfere with the return circulation through the veins, the limb can be soon drained of its blood, especially if the process is aided by rubbing the superficial venous trunks with the hand from below upward.

As soon as the vessels become emptied, the tourniquet must be screwed down with sufficient firmness to interrupt the circulation in the limb and to maintain the advantage thus gained. If this plan is properly carried out, very little blood will be lost in the operation.

Some surgeons dispense with the tourniquet altogether, and depend on digital compression for commanding the artery, or use, instead thereof, Es-march's elastic bandage. The first is unreliable, as it leaves the vessel in charge of a force which can rarely be unremittingly maintained for any considerable length of time, and is consequently inefficient, besides requiring for its execution an additional assistant. By the second plan, that of the elastic strap, the limb can be rendered bloodless, though it is followed by much oozing of blood from the sudden distention of the vessels after the removal of the band, requiring an unusual number of ligatures, and the consumption of considerable time in controlling the bleeding. Yet the saving of blood is so great, and the individual features of the stump are so distinctly exposed, that the defects of the plan are fully compensated for.

LIGATION OF THE ARTERIES.—After the operation has been completed, the surgeon proceeds to tie the vessels. Their position on the face of the stump can be readily determined by recalling their anatomical relations. If they cannot be located or identified, in consequence of their being buried in the tissues by retraction, the tourniquet may be unscrewed a little, so as to admit a current of blood, when a jet of the latter will reveal their situation, after which the instrument can again be tightened.

It will be proper, in securing the arteries, to take them in the order of importance, that is, the largest first, and afterwards those of minor magnitude, though the surgeon may deviate from this course when the necessity exists. Each vessel should be seized by the tenaculum or by an artery forceps, separated as much as possible from all its surrounding connections, and tied either with the animal or the silk ligature. If the first, the one which I prefer, is used, both ends of the thread should be cut off after making the knot. If the silk thread is used, one end only will require to be severed, and this close to the knot, the other being left.

When the surgeon is short of assistants, by using the artery forceps, with a catch or a slide, he may tie the vessels without any help, as the weight of the instrument, when allowed to hang, will draw the artery sufficiently far out for the application of the thread.

The nerves must be carefully excluded from the ligature. Nor should the veins be unnecessarily tied; although I have never seen an ill effect follow their inclusion.

The old mode of carefully isolating the vessels before tying is, I fear, becoming somewhat obsolete, as muscle and fibrous tissue are often raised and secured with the vessels,—a practice which, I am confident, complicates the subsequent healing, by causing a larger amount of devitalized tissue or sloughs in the wound.

After the ligation of the principal arteries the tourniquet, or elastic cord, may be loosened, in order to ascertain if there remain any vessels requiring to be tied. In some instances a general oozing of blood from the stump will occur. This is generally venous blood, and its flow depends on the constriction of the tourniquet, or cord, and will quickly subside when the pressure of the one or the other is relaxed.

Occasionally a free bleeding occurs from the vessels of the medullary tissue of the bone, to arrest which a piece of aseptic lint may be laid against the end of the latter for a short time, in case the oozing should not cease after the removal of the tourniquet.

Nerves.—Any nerves which are seen extending beyond the level of the stump must be drawn out and cut off. Otherwise they are liable to become incorporated with the cicatrix, and may give rise to a painful state of the stump.

Tendons or shreds of muscle which protrude too much require also to be retrenched.

All irregularities or spiculæ at the end of the bone must be dealt with by the cutting pliers.

Closing the stump.—The stump should not be permanently closed until all bleeding, or even oozing of blood, has ceased. Clots, however small they

may be, remaining in a wound are foreign bodies. They undergo decomposition, and thereby not only increase the traumatic fever, but postpone quick union by favoring suppuration.

The practice suggested by Dupuytren, and afterwards inculcated by Liston and Syme, of allowing the stump to remain open for a short time, was sound, and worthy of general imitation, during the preaseptic period. The details were as follows:

As the puncture of the needle was attended with considerable pain, wire sutures were introduced, each suture three or four inches in length, as soon as the ligation of the vessels was over, and their ends loosely twisted together.

After the lapse of half an hour or an hour, no signs of bleeding being present, preparations for closing the stump were commenced. To do this properly it was necessary to consider the condition of the surface of the wound, and the changes which it undergoes very soon after the operation. These changes result from the mechanical violence and vascular clots. The edge of the knife, however keen, being the counterpart of a fine saw, causes numberless minute lacerations of the tissues which it divides, so that, if the surface of the stump is viewed through a magnifying-glass, it will present a vast number of ragged points. (Fig. 1148.)

FIG. 1148.



Appearance of a stump after amputation.

Most of these become sloughs, which soften, and, separating from their connection with the living tissue, are washed out of the wound with the discharges. A vast number of minute vessels which do not require the ligature are also divided. Their canals become plugged with coagula, which are sufficient to prevent any bleeding. The effect on the circulation of thus lessening the blood-channels is followed by an undue vascular fullness, which results in a transudation of the liquor sanguinis, with numberless cell-forms. It is the fibrinous part of this which, adhering to the surface of the divided tissues, gives to the latter a glazed appearance, while the thinner or serous part of the transudation finds its way out of the wound. It is this blood-stained fluid which soaks first the dressings of the stump.

The retention of this fluid, mingled as it must be with fragments of devitalized tissue, is prejudicial in two ways. Entering the vessels, it intensifies the traumatic fever; by infiltration and distention of the soft parts, it favors suppuration, and consequently retards the process of repair. For these reasons, when an amputation was done after the above plan, an unobstructed way for the escape of the traumatic discharges had to be opened,—a matter of just as much importance after other plans of amputation. This was accomplished—*first*, by avoiding too great a redundancy of flap, in which pouches or diverticula might be formed, serving to collect the sewage of the stump; *secondly*, by a dependent position of the line of approximation and the use of a drainage-tube,—the silk thread employed for tying the arteries serving a purpose in the way of drainage; *thirdly*, by introducing no more sutures than were sufficient to retain the flaps together. The practice of placing adhesive plaster across the spaces intermediate to the sutures, or across the wound at all, was not only unnecessary, but was really harmful, by closing orifices which otherwise would have given exit to pernicious accumulations. Lastly, the dressing applied over the stump was such as possessed excellent absorbent properties, and was not covered by any material impervious to moisture.

The next step was the closure of the stump, the drainage-tube having

been introduced across the wound with the ends projecting from its angles, along with the ligatures, when other than the animal thread was used.

It was not necessary, however, to bring all the ligatures out of the angles of the wound. They could be brought out at other points more convenient to their attachments, as they would, by being so distributed, more effectually drain away the discharges of the stump.

The surgeon next twisted together the ends of the silver sutures until the approximation was completed. A piece of patent lint, paper lint, or old linen, which had been previously treated with a thirty per cent. solution of carbolic acid, and afterwards allowed to dry, was then placed over the stump as a cap, covered in with a pledget of soft oakum, and held in position by recurrent and circular turns of a roller, which were afterwards continued up the limb to the first articulation, or higher if the muscles above required compression. The member was then laid in a cradle or a sling, with the end of the stump depressed. (Fig. 1149.)

It is scarcely necessary to say that amputations, like all other wounds, should be made and dressed throughout antiseptically. The parts are to be subjected to the preliminary cleansing, the surgeon, assistants, and instruments to be clean, the wound to be doused with the sublimate solution, the vessels to be ligated with catgut, a drainage-tube to be placed across the wound, the flaps to be accurately stitched together and dusted with iodoform, a strip of protective to be laid over the line of approximation, pads of sublimated, carbolized, or iodoform gauze to be placed over the stump, reinforced by a quantity of salicylized absorbent cotton, and the whole to be kept securely in place by numerous recurrent and circular turns of a sublimated or carbolized roller.

A few of the early comparisons between the antiseptic plan and the old plan of treating amputations are presented below. At Newcastle-on-Tyne,* in which equal periods of time were given to the two plans of dressing, the evidence was immensely in favor of the Lister method.

Ordinary Dressing.

Year.	Major Amputations.	Deaths.	Mortality, per cent.
1873.....	27	16	59.2
1874.....	41	19	46.3
1875.....	30	14	46.6
Total.....	98	49	

Antiseptic Dressing.

Year.	Major Amputations.	Deaths.	Mortality, per cent.
1876.....	26	6	23
1877.....	32	5	15.6
1878.....	50	2	4
Total.....	108	13	

In 8 amputations done by Barwell at the Charing Cross Hospital,† viz., 2 of the thigh, 4 of the leg, and 2 of the foot, all dressed antiseptically, there were no deaths.

At the Manchester Royal Infirmary, 35 amputations treated by a modified antiseptic plan resulted in 4 deaths and 31 cures, or a death-rate of 11.42 per cent.

31 cases dressed by the Lister details gave 30 recoveries and 1 death.

Against these results, Mr. Callender‡ gave 44 consecutive amputations without antiseptic treatment, with only 1 death.

In the Pennsylvania Hospital during four years, from 1874 to 1878, 100 amputations were treated in the ordinary way, with 17 deaths, or a death-rate of 17 per cent.

At the time the above observations were made, the question of mortality

* Lancet, June 8, 1878.

† Lancet, March 8, 1878.

‡ St. Bartholomew's Hospital Reports for 1874, vol. x. p. 133.

was still held *sub judice*. The lapse of years, however, has fully vindicated the justice of the claims made for aseptic surgery.

Maisonneuve, of Paris, adopted a plan of dressing stumps which he termed *pneumatic occlusion*, the object being to drain away the accumulations from the wound by aspiration. For this purpose, a closely-fitting rubber cap, having an elastic tube attached to its centre, was placed over the stump. The free end of the tube was connected with a glass jar, from which the air was occasionally exhausted by an air-pump, thus sucking out and bottling up the discharges. Professor Wood, of New York, speaks very favorably of leaving the stump without any tight dressings.

REMOVAL OF DRESSINGS.—The first dressing should not be disturbed earlier than the third or fourth day, the period for removal being dependent on the temperature, on the odor emitted, or on the degree to which the wrappings are soiled.

In removing the dressings and in applying others, the utmost gentleness and care must be observed in handling the limb, so as not to disturb the delicate adhesions which have begun in the tissues of the stump; this might be done by exciting muscular contractions, or by altering the relations of the soft parts by pressure, in either event giving rise to pain. Indifference on this point certainly does materially complicate the healing after amputation.

With a view to insure the desired rest, and to render it practicable to dress a limb with the least possible disturbance, I have had constructed a cradle (which was suggested by an appliance devised for a similar purpose by Mr. Callender, of London), by which a dressing can be removed from the leg or the thigh and another substituted without causing the least disturbance or pain in the wound. (Fig. 1149.) This cradle or trough is made of per-

forated galvanized iron, and consists of a number of segments, connected one with another by a hinge, and which can be let down by drawing back a little rod placed on either side of the segments, and serving to maintain the continuity of the trough.

FIG. 1149.



Cradle for supporting a stump after amputation.

Hooks are also placed along the upper edge of each side, by which to suspend the cradle. On this metal trough the limb is laid, after the interposi-

FIG. 1150.



Stump supported in a suspended cradle, and one segment dropped previous to dressing.

tion of a pillow of absorbent cotton, which forms an easy bed for the limb, and at the same time soaks up the discharges from the stump. (Fig. 1150.)

The form of this trough causes the end of the stump, when suspended, to dip downward, thus preventing the water from running up the limb instead of back into the basin, which should be placed underneath, during the dressing.

The arm can be supported in a similar manner. If the stump is not suspended, it should be placed upon a pillow over which is laid a piece of rubber- or oil-cloth, with a towel interposed between the latter and the limb. To add to the security of the stump, and to guard against its being displaced by muscular starts, a strip of bandage should be placed across the limb and the ends pinned to the pillow beneath. (Fig. 1151.)

After the first renewal of the dressing, a second will not be necessary for five or six days; and were it not that the drainage-tube must be removed, a longer period might elapse before repeating the dressing. The same care must be observed, as to antiseptic details, as was practiced at the time of the operation. After the union of the flaps, a strip of iodoform gauze, smeared with boracic ointment and laid over the end of the stump, and supported by a pad of absorbent cotton and a roller-bandage, is all that is necessary.

STRUCTURE OF STUMPS.—The dissection of a stump (Fig. 1152), conducted at a time when the ordinary change of tissue has been completed (that is, after the lapse of one or two years), reveals a mass of fibrous tissue. It matters not how large a cushion of muscles or how much adipose matter may have been included in the flaps and placed over the ends of the bone, it will all have disappeared, leaving only the connective element which served to unite its fasciuli, which, together with that included in the subcutaneous tissue and some new formation of the same material, constitutes the covering of the stump. The extremities of the nerves are somewhat enlarged, and, in many instances, bulbous. When the structures of these enlargements are unraveled, they are found to consist of interlacing fibres of connective tissue, mingled with nerve-fibrillæ. The vessels which have been tied are found obliterated as high as the first collateral branch, all below being fibrous cords. The extremities of the bones are irregularly rounded, their medullary canals filled with compact osseous tissue for some distance. If a considerable period has elapsed after the amputation, the centre of this compact tissue will be found somewhat spongy or porous, which indicates a tendency to restore both the medullary canal and the surrounding cancellated tissue. Occasionally, when there are two bones in the stump, as in the forearm or the leg, these are connected by a bridge of osseous tissue.

Complications following Amputation.

The complications which follow an amputation may be primary or consecutive, local or general.

Primary Local Complications are hemorrhage, spasm, inflammation, inordinate suppuration, gangrene, protrusion of the bone, and osteomyelitis of the stump.

FIG. 1151.



Stump secured to pillow.

FIG. 1152.



Section exhibiting the structure of a stump one year after an amputation of the arm.

Hemorrhage may occur a few hours after the completion of the dressing, or it may set in after the lapse of three or four days, and may be arterial or venous. When it takes place early, it probably comes from some vessel or vessels which have been overlooked during ligation. It may proceed from an atheromatous artery, which, in consequence of the brittle state of its coats, has broken down under the constriction of the ligature. Or it may be the result of a too vigorous reaction, causing the displacement of the clots in the small vessels, which, from their size, do not ordinarily demand ligation. Or, finally, it may come from the bone.

When the hemorrhage is venous, it can be distinguished by its dark color, and may be caused by the roller being too tight above, instead of compressing the limb with a uniform pressure. It is not uncommon to find the dressings, a few hours after an amputation, wet through with a blood-stained watery fluid. But this does not require any special interference, as it gradually subsides spontaneously. When, however, the dressings are found soaked with red or dark blood, the stump should be carefully examined.

TREATMENT.—The treatment consists in first elevating the stump. If this fails to arrest the flow, the dressings must be removed and others applied, followed by a firmer compression of the stump and limb with a roller bandage. Cold water and ice may also be placed over the parts. If all this proves unavailing, there is no alternative left but to open the stump and seek for the offending vessel, whether artery or vein, and apply a ligature.

When the bleeding comes from the medullary canal, a small compress of lint, to which a thread is attached, should be placed against the bone. The cord can be brought out through the wound, so that the pledget can be withdrawn after two or three days.

Sometimes the hemorrhage proceeds from one of the vessels in the compact tissue of the bone, when it is best controlled by pressing a little beeswax into the orifice; or, if this does not answer, by spiking the osseous canal with a piece of soft wood sufficiently long to project through the wound when the flaps are replaced, so that it can be extracted at pleasure.

Spasms of the Stump.—In aged persons and those of a nervous, irritable temperament there is frequently a painful jerking or twitching of the muscles of the stump, which is a source of great distress. These spasms may involve muscles other than those which have been divided in the amputation. Thus, after the removal of the forearm above the wrist, I have seen the biceps flexor cubiti more affected than the muscles of the stump itself.

TREATMENT.—The judicious application of a roller, by supplying through firm pressure what the muscles have lost in tension, will, in most cases, prevent the development of spasms. Where the latter are more than ordinarily severe, after amputation of the forearm, I have found great relief result from the application of an anterior or an internal angular splint to the limb. A change in the posture of the extremity, such as flexion or elevation, will frequently exercise a salutary influence in diminishing the twitchings.

Should these measures fail, a hypodermic injection of morphine will procure the necessary quiet, or the anodyne may be given by the mouth, either with or without the addition of the bromide of potassium.

When the spasm and pain make their appearance two or three days after the amputation, a warm flaxseed-meal poultice should be laid over the stump, and, in conjunction with the remedies already named, will produce the happiest effects.

Inflammation, Suppuration, and Mortification may attack a stump. The inflammation may be common or erysipelatous. This complication does not occur earlier than the second or third day, and may appear much later. It is frequently excited by imperfect drainage, or it may arise from defective hygienic conditions, by which the wound becomes infected through carelessness in the use of dressings or from atmospheric impurities.

The stump becomes supersensitive, assumes a dusky red appearance, is hot, swollen, and tense, the pain being often attended with a burning, throbbing sensation. The discharges are scanty, and consist of a bloody serum or an ichorous pus. The patient becomes feverish, with a dry tongue and a parched mouth, and suffers from a considerable thirst. These symptoms are sometimes preceded by a chill. Persons of an intemperate habit are peculiarly exposed to this complication.

An attack of this nature may terminate in suppuration at the end of the stump, in diffused suppuration, the pus dissecting up the components of the limb, or in multiple circumscribed abscesses, and, finally, in mortification of the flaps.

TREATMENT.—In the management of a case of this nature the stump should be carefully examined, to ascertain if there are any vitiated accumulations pent up in the wound, and, if so, to open at once a way for their escape by cutting one or more sutures and separating with a director the adhesions of the flaps at some point. The parts are to be enveloped in hot flaxseed-meal poultices, which should be renewed every ten or twelve hours. At the same time the pain, restlessness, and febrility must be allayed by the frequent use of the neutral mixture containing a small amount of morphia.

The appearance of healthy suppuration at the wound is quickly followed by a subsidence of both the local and the constitutional disturbance, and the healing is again resumed.

When the drift of the disease is asthenic, and the recuperative forces of the system begin to flag, it will be necessary to resort to tonic and stimulant remedies, such as quinine and iron, and to give scrupulous attention to nourishment. Opium will also prove valuable in securing rest and freedom from pain.

Abscesses, either of the diffused or of the circumscribed character, must be opened as soon as discovered, and these openings should be so planned as to contribute in the most effective way to thorough drainage.

Should the sinuses which sometimes follow these diffused abscesses not close by compression or by the injection of a weak solution of the sulphate of copper, they may require to be laid open on the director.

Mortification may attack the flaps of a stump, either in consequence of their vitality having been hopelessly impaired by the original injury, or as a result of the severe degree of inflammation. In military hospitals, where many wounded persons are crowded together, amputations are often followed by sloughing.

Its approach is indicated by a blue or purple discoloration, which gradually deepens into black, and is followed by an unpleasant odor. When arising from the primary injury, it may not materially affect the general strength unless it becomes extensive; but when it follows a destructive inflammation its depressing effect on the system is very marked.

In the management of a sloughing stump, all tension must be removed from the flaps, by dividing the sutures. The parts are to be thoroughly cleansed by a wash of permanganate of potash, which should be injected into every corner and crevice of the wound; after which fermenting poultices are to be applied, in order to remove any fetor present and to hasten the detachment of the dead tissue. The system will at the same time require support by a generous diet and by tonics and stimulants.

Protrusion of Bone is liable to occur from mortification of the soft parts covering the bone, and from the retraction of the muscles, especially where the flaps have been scant and the roller has been omitted.

If the exposure is only partial, by the use of adhesive strips with weight attached (Fig. 1153), very much after the manner of making extension in fractures of the thigh, the integuments may be drawn down sufficiently far to repair the evil to some extent; or the remnant of the flaps may be brought into sufficient proximity by adhesive strips alone to admit of a cicatrix being formed over the bone. But the stump rarely proves satisfactory, being con-

ical, unduly sensitive, and liable to ulceration. It is from this source that so much of the trouble arises in the use of artificial limbs.

FIG. 1153.



Extension applied to a scanty flap.

The only remedy for this defect of the stump is to dissect up the tissues and cut off the bone some distance above; or, in bad cases, a formal re-amputation will become necessary.

Secondary Complications.

Secondary Hemorrhage is occasionally met with after amputations, coming on at some period between the eighth and fourteenth day, and sometimes at a much later interval, after the operation. The flow may be sudden and impetuous, or slow and continuous, escaping at one or more places from between the flaps.

The causes of secondary hemorrhage are not always the same. It may arise from a premature detachment of the ligature, in consequence of atheromatous alteration in the coats of the vessels, or from sloughing occurring before the canals of the arteries have been sealed by an organized tissue. The presence of unhealthy pus in a stump has a tendency to soften and detach the coagula which close the vessel. And the same changes are favored by an unhealthy condition of the blood itself,—such as results from hemorrhage, or from a generally depraved state of the fluids. A troublesome bleeding may also be caused by enlargement of the vessels and thickening of the tissues from inflammatory deposits, incident to necrosis of the bone, and on account of which the walls of the vessels become adherent to the indurated and inelastic structures, and are thereby kept from contracting on their contents. When the bleeding is not copious, the flow may be restrained by pressure applied to the stump and along the course of the main vessel of the limb by a compress and roller. If this proves ineffectual, the time for temporizing is past. Pressure should be made on the principal artery of the extremity at different places, in order to determine the point nearest to the stump where the pressure controls the bleeding, and where it will be best to expose and ligate the vessel. In the arm and the forearm, where the arteries for the most part are very accessible, the acupuncture-pin may be substituted for ligature.

In cases where the hemorrhage is dependent on the effect produced on the vessels by the indurated tissues around a necrosed bone, preventing their contraction and retraction, the removal of the sequestrum will put an end to the bleeding. Until this can be accomplished the surgeon must rely on circumferential pressure by means of a roller.

Osteomyelitis and Necrosis.—The same inflammatory changes which make havoc with the soft parts may extend to the bone, attacking the medullary tissue, which becomes soft and discolored. The periosteum also separates, and the bone dies in its entire thickness. Cases of this nature are not unattended with danger, from the liability to constitutional infection or pyæmia.

The necrosis is sometimes attributed to the violence done by the saw in

disturbing the connections of the periosteum; but I apprehend this is rarely the case. When it does not result from inflammatory changes propagated from the soft parts, from a deficiency of flap, or from the deleterious contact with pus, it is more correctly attributed to the traumatic force which caused the injury. The frequency of this affection following amputation on account of gunshot wounds inflicted by the conoidal ball tends to corroborate the view that post-amputation osteomyelitis is the product of osseous concussion. The existence of the necrosis does not entirely defeat the healing of the soft parts, though there will remain a sinus over the stump, which continues to discharge. At the bottom of this fistulous tract may be discovered denuded bone. Nor will the opening close until the sequestrum is removed. The separation should be left to nature: it is the work of two, three, or more months; and when it is accomplished, the soft parts being separated from the sequestrum, the latter must be extracted. This, when pulled away, generally appears as a cylinder or ring, including below the entire thickness of the bone, and above that portion which forms the circumference of the medullary canal. The upper extremity of the sequestrum, being gnawed and spiculated, is strikingly in contrast with the lower, which is quite smooth on its surface.

Conical Stump.—This troublesome condition is the result of insufficient flap, of retraction of the muscles, and of sloughing, leaving the bone to be covered by granulation tissue. (Fig. 1154.) Stumps of this form are useless for the purpose of support, and are constantly exposed to ulceration, as the cicatrix possesses very little vitality. The remedy is re-amputation.

Bulbous Enlargement of the Bone.—In some instances a profuse outgrowth of granulation tissue arises from the medullary structure, and, spreading over the cut end of the bone like a cap, is gradually transformed into callus, making a nodular mass, which either interferes with the closure of the wound or exerts an injurious pressure against the cicatrix. The treatment consists in cutting off the bone above the enlargement.

Neuralgia.—One of the most distressing affections which can befall a

FIG. 1154.



Conical stump, from a patient in the Pennsylvania Hospital.

FIG. 1155.



Appearance of the nerves of a stump after amputation.

stump is neuralgia. It has both a local and a constitutional origin. When dependent on a local cause, it is due to bulbous enlargement, which takes place in the cut ends of the nerves of the stump. (Fig. 1155.) This change

is the usual one after amputation, and in a large proportion of cases is unattended with any inconvenience.

These enlargements, which consist of interlacing bundles of connective tissue, may undergo hypertrophy, becoming as large as a marble or even a walnut; and it is then that they occasion so much suffering. They are more generally met with after amputation in the upper extremity.

The least pressure over these indurated masses is attended with exquisite pain. The contraction of the muscles of the stump in the ordinary movements of the limb is also productive of constant suffering. The disease may reside in a single nerve of a stump, or several nerves may be simultaneously affected.

In other cases a nerve becomes incarcerated in the cicatrix of a stump, causing a supersensitive condition of the latter. Both conditions are capable not only of creating severe pain, but also of exciting violent spasms and tremors of the muscles of the limb.

The treatment proper for these fibrous neuromata is to open the stump and excise the diseased bulbs; or, where a number exist, the remedy is re-amputation.

Where the inordinate sensibility is to be referred to a nerve becoming involved in the cicatrix, the removal of the latter by excision is the course to be adopted.

There is another condition of a stump which is attended with agonizing pain, and not unfrequently with a distressing sense of the constant presence of the amputated part. The patient dreads the slightest touch of the surface of the stump, complains often of the lost toes or fingers being forcibly drawn asunder, and is rendered incapable of attending to any business. An examination will often fail to discover any tangible evidence of a change in the nerves of the sensitive part. These are cases in which the evil is central and constitutional, and are rarely benefited by an operation, though, after a long time, the disability may wear away.

A physician in Western Pennsylvania once applied to me for counsel in regard to such a condition in his own person. He had, while answering to a call during a dark night, ridden into the top of a fallen tree, and, being thrown from his horse, had his elbow so crushed as to necessitate amputation of the arm immediately above the elbow. The operation was followed by a painful cicatrix, which continued to grow steadily worse until, other measures failing, he had submitted to a second amputation. No improvement followed the operation, and, in consequence of the unremitting suffering which he experienced, he was compelled to abandon all professional work and come to Philadelphia for relief. He was desirous of having the remaining portion of the arm removed at the shoulder-joint. I dissuaded him from this, and proposed instead the excision of the axillary plexus of nerves, though at the same time speaking very distrustfully of the relief which might be expected from such a procedure. The operation, a most tedious and troublesome one, however, was done, and, although not followed by entire exemption from the old pain, the latter was so greatly modified in its character that the patient returned home, was able to resume his professional work, and finally, after several months, got entirely well.

Sometimes the muscular spasms are confined to a single group of muscles, when temporary and occasionally permanent relief may be obtained by excising a considerable portion of the main trunk of the nerve supplying the affected muscles. In a hospital patient who had long been harassed with a sense of violent abduction of the foot after an amputation of the lower third of the leg, I succeeded in removing this ideal distortion by cutting away a portion of the peroneal nerve below the head of the fibula, thus paralyzing those muscles whose function it is to produce this particular movement. No operation, however, will have any effect in destroying the consciousness of the presence of a lost part of a limb, as the sensation is due to psychical and not to material conditions.

In that neuralgic condition of a stump which comes on independently of any discoverable nerve-lesion, and which is often influenced by atmospheric changes, and also by mental and physical excitement, constitutional remedies alone are to be employed, such as quinine and arsenic in full doses. If there are signs of anæmia, iron will also be indicated; and when the pain is excessive, the hypodermic use of morphine will give temporary relief. These cases are frequently not amenable to treatment.

Contraction of Tendons.—In amputations below the knee, where the leg has long been allowed to remain flexed, the hamstring muscles may become so shortened as to offer great resistance when an attempt is made to straighten the stump.

The difficulty is usually overcome by repeated efforts at extension of the leg.

The same difficulty may occur at the elbow, by long contraction of the biceps muscle, and is to be treated in a similar way.

After the amputation known as Chopart's, the heel may be drawn up by the action of the tendo Achillis so as to bring the foot into a position which will expose the cicatrix to pressure. Tenotomy and a properly-adjusted splint constitute the appropriate means for correcting this evil.

Aneurismal Varix.—This very rare condition I have only once witnessed. The subject was a negro boy, whose thigh had been amputated at the lower third five years previous. A connection had formed between the femoral artery and the femoral vein at the extremity of the stump, most probably due to both vessels having been included in the same ligature at the time of the operation. All the veins of the limb were distended, varicose, and pulsated strongly, yielding the peculiar sound which belongs to this form of aneurism. Mr. Cadge, of Norwich, England, has recorded a similar condition affecting the posterior tibial arteries and veins of the leg after an amputation at the ankle-joint.

Cases of this nature are not proper subjects for surgical interference, and do not specially endanger the life of the patient.

Degeneration of the Tissues of a Stump.—The structures immediately related to a stump gradually undergo *fatty* and *fibrous* transformations.

The *fatty* degeneration is one very commonly connected with diseases or injuries involving the bones. Thus, in cases of necrosis, the overlying muscles are found to be largely replaced by fat, though they may still retain their form and measurably their size, the adipose material having displaced the sarcoous substance, leaving only the connective tissue of the muscle, and giving to the latter a yellow appearance. The same change occurs in the tissues of a stump.

The *fibroid* hypertrophy, in which there is a large increase of the connective tissue of a stump, is attended with undue sensibility of the parts, and is an inflammatory product, caused by undue pressure, generally from a badly-fitting artificial limb. It may be accompanied by obstinate ulceration, rendering it necessary, in some cases, to open the stump, remove the indurated tissue, and retrench the bones.

Malignant degeneration.—After amputation for cancer, the disease may reappear in the tissues of the stump. Such an occurrence is an expression of a widely-disseminated vice, and gives no encouragement to repeat the operation.

Bursa.—Continuous pressure on the end of a stump may be instrumental in producing a bursal sac, which can be readily recognized as a slightly fluctuating swelling, over which the skin presents a wrinkled or rugose appearance. This sac is liable to become inflamed and to cause serious inconvenience to the patient.

The remedy is to relieve the end of the stump from all pressure. The stimulus being removed, the bursa will spontaneously disappear. It would be an aggravated case which would justify excision.

Simultaneous Amputations.

The necessity for the removal of two or more limbs will occasionally arise as a result of railroad and other accidents, and, with few exceptions, it is better that the operations should be executed simultaneously.

The *morale* of the patient is better at the primary than at any other period; and as far as my own observation extends, which is limited to five cases, the shock succeeding the double amputations did not appear to be materially greater than what would have attended a single one.

The surgeon, however, in such emergencies must be guided in his course by the condition of the patient. It would obviously be improper to remove two limbs at the same time if the person was greatly depressed at the time of operation or should exhibit serious signs of exhaustion after one amputation. In either case the second operation should be delayed until the effects of the shock have in a great measure disappeared, which may be sufficiently early to bring it within the primary period. If this does not occur, it will be best to defer action until after the inflammatory or intermediary period has passed.

Where double amputations are demanded in consequence of injury to different parts of the extremities,—as the thigh of one and the leg of the other,—and there is a doubt in the surgeon's mind as to the patient's ability to endure synchronous operations, it will be best to select for the first amputation the part of greatest magnitude, so that the consecutive operation shall inflict the least shock possible.

Even triple synchronous amputations have been done with entire success, in one instance by Dr. Koehler, of Schuylkill Haven, Pennsylvania, and in another by Dr. Stone the elder, of New Orleans. In the town of York, Pennsylvania, in 1868, the right thigh and left leg and the right forearm and three fingers of the left hand were successfully removed from a patient at one operation.

When synchronous amputations are performed, the two limbs should be removed in quick succession, the surgeon not stopping to tie any vessels until both have been cut off; or the vessels of one limb may be secured by an assistant while the other is being removed.

More than usual care, under these circumstances, must be observed in adjusting the tourniquet so as to control the circulation and prevent as far as possible the loss of blood. The elastic bandage of Esmarch can be used with advantage in cases of this nature; or in amputations of both lower extremities the circulation can be completely arrested by the application of the abdominal tourniquet.

If two surgeons are present, the operations may be strictly simultaneous, by each taking a limb,—a plan which has the advantage of diminishing the time consumed in the amputation, and, consequently, of lessening the shock.

Of 74 cases of multiple amputation performed after recent injury, collected by Dr. Baum from the sources indicated, and tabulated on the following pages, 36 died and 38 recovered.

In three cases performed by myself, all were successful.

Dr. Alexander, of Topeka, Kansas, performed successfully a triple amputation,—the parts removed being the right forearm, the right thigh at the lower third, and the left leg.

Simultaneous Multiple Primary Amputations.

Source of Information.	Parts amputated.	Died.	Cured.	Remarks.
Guy's Hospital Reports, Series III., vol. xv. p. 630. From 1861-68 (inclusive).....	Legs.....	2	1	
	Thigh and leg.....	3	1	
From 1862-78 (inclusive):	Leg and arm.....	2	1	
Vol. xvi. p. 571.....	Thighs.....	1	1	
Vol. xvii. p. 520.....	Legs and hand.....	1	1	
Vol. xix. p. 535.....	Knee-joint and thigh.....	1	1	
Vol. xx. p. 556.....	Right hip and left thigh.....	1	1	
Vol. xx. p. 556.....	Legs (three cases).....	3	1	
Vol. xx. p. 556.....	Forearms.....	1	1	
Vol. xxi. p. 446.....	Legs.....	1	1	
Vol. xxi. p. 446.....	Thigh and forearm.....	1	1	
Vol. xxii. p. 490.....	Ankle-joints.....	1	1	
St. Thomas's Hospital Reports, 1870-77 (inclusive):				
Vol. i. p. 676.....	Feet.....	1	1	
Vol. iv. p. 318.....	Legs.....	1	1	
Vol. v. p. 434.....	Left hip and right ankle.....	1	1	
Vol. vi. p. 354.....	Legs.....	1	1	
Vol. vii. p. 372.....	Three cases (parts not stated)....	1	2	
Vol. viii. p. 645.....	Legs.....	1	1	
St. George's Hospital Reports, 1865-76 (inclusive):				
Vol. i. p. 426.....	Legs.....	1	1	
Vol. iii. p. 370.....	Arms.....	1	1	
Vol. iv. p. 341.....	Legs.....	1	1	
Vol. v. p. 310.....	Thighs.....	1	1	
Vol. vi. p. 368.....	Legs.....	1	1	
Vol. vii. p. 298.....	Thighs.....	1	1	
Vol. vii. p. 300.....	Thigh and forearm.....	1	1	
Vol. viii. p. 487.....	Legs.....	1	1	
Vol. viii. p. 487.....	Thighs.....	1	1	
Vol. viii. p. 489.....	Wrists.....	1	1	
Vol. viii. p. 490.....	Thighs (died on table).....	1	1	
St. Bartholomew's Hospital Reports, Appendix:				
Vol. xli. p. 70.....	Legs.....	1	1	
Vol. xli. p. 70.....	Arms.....	1	1	
London Lancet, 1860-78 (inclusive):				
Vol. ii., 1868, p. 185.....	Right thigh and left leg.....	1	1	
Vol. i., 1869, p. 878.....	Legs.....	1	1	
Vol. ii., 1872, p. 814.....	Legs.....	1	1	
Vol. i., 1873, p. 629.....	Left leg and right arm.....	1	1	
Vol. i., 1873, p. 629.....	Thighs (middle and supra condyloid).....	1	1	
Liverpool Medical and Surgical Reports, 1867-71 (inclusive):				
Vol. i. p. 87.....	Thighs (at middle third).....	1	1	
Vol. iv. p. 158.....	Legs.....	1	1	
Vol. v. p. 120.....	Legs.....	1	1	United with Manchester in 1872.
Liverpool and Manchester Medical and Surgical Reports, vol. v. p. 243.....	Arms.....	1	1	
Medical Times and Gazette, 1860-78 (inclusive), vol. i., 1876.....	Right arm and left tarsus.....	1	1	
	Thighs.....	1	1	
	Left arm and leg and anterior half of right foot.....	1	1	
Harrisburg Hospital, 1874-79 (inclusive).....	Thigh and leg.....	1	1	Thos. J. Dunott, M.D., operator.
	Legs.....	1	1	
	Thighs.....	1	1	
During 1874, at Johnstown, Pa.....	Legs.....	1	1	W. B. Lowman, M.D., operator.
New York Medical Record, vol. viii. p. 281, 1866-79 (inclusive).....	Leg and foot.....	1	1	
American Journal of the Medical Sciences, vol. xliii. p. 537.....	Forearms.....	1	1	Taken from Glasgow Med. Jour., Jan. 1862.
Hospital Gazette and Archives of Clinical Surgery, 1878.....	One case.....	1	1	
Medical and Surgical Reporter, vol. xxv. p. 60, 1860-78 (inclusive).....	Thighs and right forearm.....	1	1	Dr. Harten, of Horde, Germany, operator.
At York, Pa., 1868.....	Right thigh and left leg; right forearm and three fingers of left hand.....	1	1	
Medical Times and Gazette, 1861, April 20, p. 416 and p. 493.....	Right forearm and left hand.....	1	1	
	Right knee-joint and left leg, one inch below knee.....	1	1	
	Right leg and left toes.....	1	1	
	Legs.....	1	1	

Simultaneous Multiple Primary Amputations.—(Continued.)

Source of Information.	Parts amputated.	Died.	Cured.	Remarks.
Surgical Reports and Miscellaneous Papers, by George Hayward, M.D., from cases at Massachusetts General Hospital, p. 148 and p. 157; also, American Journal of the Medical Sciences, vol. xxvi. p. 66	Legs..... Forearm and arm..... Thigh and leg.....	1 1 1	..... 1	
American Journal of the Medical Sciences, July, 1854, p. 14, vol. xxviii. Notes from Pennsylvania Hospital Statistics	Legs..... Feet.....	1 1	1 1	
Amer. Jour. Med. Sci., 1875, vol. lxi. p. 319....	One case (parts not stated).....	1	1	
Verbal report.....	Hip-joint and lower third of leg	1	1	Dr. John Ashhurst, operator.
		36	38	

RE-AMPUTATION may be necessitated by a badly-formed or a diseased stump. For example, the flaps may slough or become retracted so as to expose the bone. The bone itself may be the subject of disease, as of necrosis or osteomyelitis, or the nerves of the stump may become so exceedingly painful from an enlarged state of their extremities as to require a second amputation.

The rules to be observed in re-amputation are such as have reference to time and place.

The *proper time* is when the patient's general strength is sufficiently established for him to undergo the operation, and when the soft parts are in a healthy state.

The *place* must be determined by local conditions, always selecting a point which will secure a sufficient covering for the bones.

When the bones are necrosed or affected with osteomyelitis, the flaps must be formed with a view to exploration, and the section made in sound osseous tissue.

In osteomyelitis it is often difficult to determine the limits of the disease, especially after gunshot injuries inflicted by the conoidal ball, in which the concussion is widely felt through the fibres of the bone. If upon examination, therefore, the disease is found to be very near to an articulation, the most prudent course will be to amputate in the continuity of the limb or at the contiguous joint.

Intra-Uterine Amputations.

These are such as occasionally occur in the fœtus, produced most probably through the agency of bands of lymph, as pointed out by Montgomery.* These bands, when encircling a limb, gradually, by their contraction, effect its amputation. The writer just named found in a fœtus of five months a complete ligation around each hand, causing a distinct groove where it passed; the parts below were imperfectly developed. Similar bands encircling each ankle had divided two-thirds of their thickness, but without any lesion of the skin.

Mr. Watkinson met with a case in which the left foot, above the ankle, had been amputated by the same process.

M. Chaussier has described three cases, two of the forearm and one of the arm and hand. In the latter the amputated part was lying in the membranes, and the stump had healed.

A specimen of this amputation is mentioned in Leishman's Midwifery as being in the possession of the Obstetric Museum at the University of Edin-

* Dublin Journal of Medical and Chemical Sciences, vol. i., 1839.

burgh. The separated portion was the left forearm. The subjoined table contains eight cases of similar amputations.

Spontaneous Amputations in Utero.

Source.	Part amputated.	No.	Reporter.
New York Medical Record: Vol. i. p. 27.....	Right leg, 4 inches below knee, with constriction of thigh, 4½ inches above knee.....	1	Oscar H. Young, M.D.
Vol. v. p. 420.....	Right arm, ½ inch below elbow.	1	George Pepper, M.D.
Vol. v. p. 420.....	Right arm, at junction of upper and middle thirds	1	J. F. Wilson, M.D.
Med. and Surg. Reporter, vol. xxxiii. p. 217.....	Just below insertion of biceps, on left forearm.....	1	Dr. Macau.
Boston Med. and Surg. Journ., New Series, vol. iii. p. 409...	At left metacarpus.....	1	Dr. Paul Munde, Bavaria.
Vol. iv. p. 81.....	Finger, at metacarpo-phalangeal joint.....	1	Mr. Ed. Cheatte, Edinburgh.
	Right arm and left forearm.....	1	Dr. Little, reported verbally.
	Thigh by knotted cord.....	1	Dr. Thom, Toledo, Ohio, by letter.
		8	

Artificial Limbs.

The time when an artificial limb may be worn after an amputation is a point in respect to which surgeons differ. The condition of the stump must, of course, in a great measure, determine the period when it will be advisable to adjust such an appliance. Neither the presence of an ample covering nor the completion of the cicatrization of the stump is evidence of the fitness of the parts to endure to the best advantage the pressure necessarily connected with wearing an artificial limb. The cicatricial tissue continues to condense and to become more compact with the lapse of time. It also becomes more loosely connected with the subjacent parts, so as to move with greater freedom over the surface of the stump. As these changes require time for their perfection, it is rarely the case, in my judgment, that a limb is ready to receive any prosthetic mechanism earlier than three months after the healing.

It is only to the lower extremity that an artificial limb can be adjusted so as to have any practical value. Those limbs which are designed for the upper extremity answer very well for purposes of parade or appearance, but as a means of prehension are almost worthless.

For the lower extremity there are two kinds of mechanism worn,—the old peg (Fig. 1156) and the more modern and elegant hollow appliance, fashioned out of willow wood, having the figure of the natural limb, and with joints and cords designed to imitate the movements of the articulations and the actions of the muscles. The limbs of Palmer, of Kolbe, and of Osborne, Philadelphia manufacturers (Fig. 1157), in point of lightness, strength, elegance of construction, and utility, are entitled to special notice.

These hollow artificial limbs are constructed so as to receive the natural limb on the same principle as that by which a tooth rests in the socket of the alveolus, the pressure being distributed over the periphery of the leg or thigh, as the case may be, and not on the end of the stump. On this account accuracy of fit becomes a prime object; and this can be attained in no other way than by first taking a plaster cast of the extremity and constructing the artificial limb from the mould. The application of this principle, though it is absolutely necessary, is attended with one drawback, which appears to be unavoidable, namely, shrinkage or wasting of the limb, which is the result partly of pressure and partly of disuse of the muscles. In consequence of this change the socket after a time becomes too large for the

extremity, and requires to be changed for a smaller one, or to be filled in so as to conform to the receding soft parts.

FIG. 1156.



Peg leg.

FIG. 1157.



Artificial leg.

the skin, and also the great extent of surface, endures pressure better than any other part of the limb.

After disarticulation at the hip-joint, it is possible to wear an artificial limb with advantage. For the natural extremity in such cases is substituted, eight or ten inches, a gutta-percha stump, secured by a broad girdle buckled round the pelvis. (See hip-joint amputation.)

Amputations through the foot, such as are commonly known by the name

FIG. 1158.



Simple artificial mechanism for the forearm.

of Lisfranc, Chopart, Pirogoff, and Syme, require an ordinary boot, in which the lost of the foot is supplied by soft wood or cork. The end of the stump generally endures pressure of the superincumbent weight of the body very well. Prosthetic appliances designed for special cases are represented under the head of the different amputations.

The simplest and, for laboring persons, most useful artificial appliance after amputations below the forearm is a leather sheath

receive the stump and the arm), at the end of which is a plate with a handle. The sheath is connected with a leathern girdle, above the elbow, by straps having an articulation answering to the joint. (Fig. 1158.)

STATISTICS OF AMPUTATION.

The following tables, compiled from the reports of various civil hospitals in this country and abroad, will serve to elucidate some points of interest connected with this subject.

In Table I. are collected 14,366 cases of amputation, all of which, except 62, may be regarded as major operations. 9415 of this number recovered and 4951 died, showing an average death-rate of 34.46 per cent., or 1 in every 3 patients operated on.

This is a startling statement, but corresponds—and from larger data—with the conclusions reached by Mr. Lane and Mr. Phillips.

I.

Table of Amputations for all Causes and at all Periods; showing also the Average Mortality for Different Amputations, and also for Amputations of all Kinds.

Seat.	No. of Cases.	Cured.	Deaths.	Death-Rate.
Hand.....	62	56	6	9.67
Wrist-joint.....	115	112	3	2.60
Forearm.....	1,313	1,120	193	14.69
Elbow-joint.....	30	28	2	6.66
Arm.....	2,867	2,190	677	23.61
Shoulder.....	298	178	120	40.13
Foot.....	159	130	29	18.23
Ankle-joint.....	150	126	24	16.00
Leg.....	4,337	3,018	1,319	30.41
Knee-joint.....	215	119	96	44.65
Thigh.....	3,947	2,018	1,929	48.87
Hip-joint.....	836	305	531	63.51
Double.....	37	15	22	59.45
Aggregate.....	14,366	9,415	4,951	34.46

In Table II. there is collected a total of 5956 amputations, classified in such a manner as to show the results of such operations when performed for *injury* and for *disease*, and also for *primary* and *secondary* amputations, under each general heading.

For injury there are 3353 amputations. Of this number, 1313 died and 2040 recovered,—a mortality of 39.16 per cent. For disease there are recorded 2603 amputations, with 618 deaths and 1985 cures,—a mortality of 23.74 per cent.; showing 15.42 per cent. in favor of amputations performed for disease.

Considering next the subjects of primary and secondary operations, there were 3353 amputations executed for injury; 2572 being done during the primary period, with a death-rate of 35.81 per cent., and 781 being performed in the secondary period, with a mortality of 50.19 per cent.; showing 14.38 per cent. in favor of primary amputations.

II.

Table of Amputations with Reference to Cause and Period of Operation.

Seat.	INJURY.								DISEASE.							
	PRIMARY.	Cured.	Died.	Death-Rate.	SECONDARY.	Cured.	Died.	Death-Rate.	FOR DISEASE.	Cured.	Died.	Death-Rate.	TOTAL.	Died.	Death-Rate.	
Hand.....	49	46	3	6.12	6	4	2	33.33	7	6	1	14.28	62	6	9.67	
Wrist-joint.....	69	69	...	...	2	2	...	...	8	7	1	12.33	79	1	1.26
Forearm.....	430	384	46	10.69	89	67	22	24.94	181	164	17	9.39	700	85	12.01	
Elbow-joint.....	5	5	...	...	1	1	...	...	5	4	1	20.00	11	1	9.09
Arm.....	546	391	155	21.00	133	69	64	48.12	297	171	36	12.56	886	255	28.75	
Shoulder.....	42	21	21	50.00	6	3	3	50.00	13	10	3	23.07	61	27	44.26	
Foot.....	69	52	17	32.69	13	9	4	30.76	76	69	7	9.21	158	28	18.23	
Ankle-joint.....	19	11	8	42.10	9	8	1	11.11	47	41	6	14.93	75	15	20.00	
Leg.....	736	396	340	46.19	269	131	138	51.30	691	555	136	19.10	1696	614	36.25	
Knee-joint.....	49	34	15	30.61	14	6	8	57.34	35	26	9	25.74	98	32	32.64	
Thigh.....	513	228	285	55.55	230	85	145	63.04	1142	829	313	27.40	1885	743	39.40	
Hip-joint.....	13	2	11	84.61	5	2	3	60.00	190	102	88	46.31	208	102	49.03	
Double.....	32	12	20	62.50	4	2	2	50.00	1	1	...	...	37	22	59.45
Aggregate.....	2572	1651	921	35.81	781	389	392	50.19	2603	1985	618	23.74	5956	1931	32.42	

Table III., letter *a*, embraces a collection of 4204 major amputations, gathered from the records of sixteen different hospitals in America, Great Britain and on the Continent, 1290 proving fatal,—a death-rate of 30.68 per cent. Letter *b*, same table, exhibits the mortality for all amputations in a number of prominent hospitals, the aggregate collection of cases amounting to 5473, with 1899 deaths, or a mortality of 34.69 per cent.

III.

*Table of Mortality of Amputations.**(a) Mortality of Major Amputations.*

Where performed.	No. of Cases.	Deaths.	Death-Rate.
Bellevue and Charity Hospital.....	55	19	34.54
Birmingham Hospital.....	33	8	24.24
Boston City Hospital.....	366	145	39.61
Edinburgh Royal Infirmary.....	26	11	42.30
Guy's Hospital.....	581	206	35.45
Hôtel-Dieu de Rouen.....	47	9	19.15
Leeds General Infirmary.....	189	45	23.80
London Hospital.....	132	73	55.31
London and provincial hospitals (thigh and leg).....	640	205	32.06
Massachusetts General Hospital.....	784	193	24.61
Pennsylvania Hospital.....	712	197	27.66
Radcliffe Infirmary (Oxford).....	46	5	10.86
St. Bartholomew's Hospital.....	97	14	14.43
St. George's Hospital.....	180	74	41.11
St. Thomas's Hospital.....	181	61	33.64
Various places in England.....	135	25	19.25
Total	4204	1290	30.68
<i>(b) Mortality of all Amputations.</i>			
Boston City Hospital.....	135	56	41.44
Glasgow Royal Infirmary.....	1973	672	34.10
Guy's Hospital.....	735	253	34.42
Paris hospitals.....	1144	522	45.60
Pennsylvania Hospital.....	902	230	25.49
St. Bartholomew's Hospital.....	358	74	20.67
St. George's Hospital.....	226	92	40.70
Total	5473	1899	34.69

These figures exhibit a greater death-rate by 4 per cent. for amputations of all kinds than for those usually designated as major amputations,—an apparent anomaly which is explained by the high mortality attending operations on the foot, which is 4 per cent. greater than that attending operations done on the hand.

Table IV., containing 3521 major amputations, is arranged with a view to compare the mortality in American, London, and Parisian hospitals, the mortality being 28.81 per cent. in American, 36.70 per cent. in London, and 56.54 per cent. in Parisian hospitals.

IV.

Table of Comparative Mortality of Major Amputations in American, London, and Paris Hospitals.

Sect.	AMERICAN.			LONDON.			PARIS.		
	No. of Cases.	Deaths.	Death-Rate.	No. of Cases.	Deaths.	Death-Rate.	No. of Cases.	Deaths.	Death-Rate.
Thigh.....	560	201	35.89	535	224	41.86	199	126	63.31
Leg.....	711	224	31.50	345	136	39.52	191	105	54.97
Arm.....	306	74	24.18	173	53	30.63	91	41	46.15
Forearm.....	297	41	13.80	113	15	12.30	.....	.....	.....
Total.....	1874	540	28.81	1166	428	36.70	481	272	56.54

The American hospitals compared in the above table are the Pennsylvania Hospital, Bellevue and Charity, Boston City, and Massachusetts General; the London hospitals are Guy's, St. Bartholomew's, St. George's, St. Thomas's, and the London Hospital; the Paris table is furnished from Malgaigne's summary.

In the subjoined table a comparison is drawn between the results of amputations in five large hospitals for—with the exception of one (Guy's Hospital)—approximately a like number of cases.

V.

Table of Mortality of all Amputations in Recent Years.

Hospital.	Period of Time.	No. of Cases.	Death-Rate.
Pennsylvania Hospital.....	From 1870 to 1878.....	252	21.43
St. Thomas's Hospital.....	" 1869 to 1877.....	252	30.95
St. George's Hospital.....	" 1865 to 1876.....	230	41.30
Guy's Hospital.....	" 1861 to 1878.....	742	35.71
University Hospital.....	" 1874 to 1889.....	290	25.10

From 1874 to 1878 the whole number of amputations at the Pennsylvania Hospital was 100, with 17 deaths, or a mortality of 17 per cent.

In a grand summary of amputations at the Pennsylvania Hospital from January 1, 1831, to January 1, 1875, there were 902 amputations upon 896 patients; 663 were cured, 230 died, or 25 per cent., and 3 were removed by friends. 615 were *primary*; 460 cured, 155 died, or 25 per cent. 95 were *secondary*; 55 cured, 40 died, or 42 per cent. 185 were *chronic*; 148 cured, 35 died, or 19 per cent., and 2 undetermined.

Of the 230 deaths, 59 occurred within 5 days after the amputation, 32 between 5 and 10 days, 139 after 10 days.

Of the total number of deaths after amputations during 45 years, the mortality of the different months of these years was as follows: in January, 11 died; February, 15; March, 15; April, 16; May, 27; June, 25; July, 29; August, 22; September, 19; October, 21; November, 11; December, 19.

Of the 902 amputations, the mortality and general results were as follows:

	INJURY.								TOTAL.		
	Primary.	Cured.	Died.	Per cent.	Secondary.	Cured.	Died.	Per cent.	No.	Died.	Per cent.
Hip.....	1	...	1	100	5	2	3	60	6	4	66.66
Thigh.....	49	24	25	51	18	11	7	39	121	45	37.18
Knee.....	24	16	8	33	2	1	1	50	33	10	30.3
Leg.....	190	118	72	38	34	15	19	56	291	105	36
Foot.....	47	37	10	21	5	4	1	20	65	12	18.45
Shoulder.....	19	12	7	37	1	1	...	5	25	7	28
Arm.....	107	87	20	19	19	12	7	37	137	29	21.1
Forearm.....	127	115	12	9	15	10	5	33	160	18	11.24
Elbow.....	3	3	...	...	...	...	...	...	3	...	...
Wrist and hand.....	48	48	...	...	1	1	...	3	52	...	...

Causes of mortality after amputation.—Age exerts a marked determining influence on the mortality of amputations. Of 881 patients who have undergone amputations in the Pennsylvania Hospital, and whose ages have been recorded, 288 were under 20 years, of whom 246 were cured, and 42 died, or 15 per cent.; 259 were between 20 and 30 years, of whom 193 were cured, and 66 died, or 25 per cent.; 176 were between 30 and 40 years, of whom 124 were cured, and 52 died, or 30 per cent.; 105 were between 40 and 50 years, of whom 71 were cured, and 34 died, or 32 per cent.; 53 were upwards of 50 years, of whom 28 were cured, and 25 died, or 47 per cent.

The capacity to resist the influences which tend to destroy life appears, therefore, to diminish steadily from youth upward.

The fatality resulting from *shock* varies in different hospitals, being greatest in those located near large manufacturing and railroad centres. Of the amputations tabulated above, so far as can be determined, a little over 32 per cent. of all fatal cases perished from causes directly referable to the injury, as hemorrhage, shock, pyæmia, tetanus, and renal disease. The small number of deaths from hemorrhage (7 per cent.) after amputation at the Pennsylvania Hospital is quite striking.

The following cases, collected, at my suggestion, from London hospitals by Dr. Adler, show, in a striking manner, the influence of antiseptics in reducing the mortality after major amputations.

Seat.	PRE-ASEPTIC PERIOD.			ASEPTIC PERIOD.			Mortality per cent. in favor of Aseptic Period.
	No. of Cases.	Deaths.	Mortality per cent.	No. of Cases.	Deaths.	Mortality per cent.	
Thigh.....	535	224	41.86	787	214	27.19	14.67
Leg.....	345	136	36.52	698	108	15.47	21.05
Arm.....	173	53	30.63	220	46	20.91	10.72
Forearm.....	113	15	12.30	172	5	2.91	9.39
Grand total.....	1166	428	36.70	1877	373	19.87	16.83

Where Performed.	PRE-ASEPTIC PERIOD.			ASEPTIC PERIOD.			Mortality per cent. in favor of Aseptic Period.
	No. of Cases.	Deaths.	Mortality per cent.	No. of Cases.	Deaths.	Mortality per cent.	
St. Bartholomew's Hospital..	358	74	20.67	629	108	17.17	3.50
Guy's Hospital.....	735	253	34.42	783	186	23.75	10.67
St. Thomas's.....	181	61	33.64	465	79	16.99	16.65

Period of Operation.	PRE-ASEPTIC PERIOD.			ASEPTIC PERIOD.			Mortality per cent. in favor of Aseptic Period.
	No. of Cases.	Deaths.	Mortality per cent.	No. of Cases.	Deaths.	Mortality per cent.	
Primary.....	2572	921	35.81	470	114	24.26	11.55
Secondary.....	781	392	50.19	180	62	34.44	15.75
Disease.....	2603	618	23.74	1227	197	16.06	7.68
Grand total.....	5956	1931	32.42	1877	373	19.87	12.55

Table showing, from 444 Fatal Cases of Amputation, the Percentages of Deaths referred to Chief Causes.

	Shock, Col- lapses, and Exhaustion.	Pyæmia and Septi- cæmia.	Secondary and Recur- rent Hem- orrhage and Gangrene.	Erysipelas.	Tetanus.	Visceral Complica- tions.	Bronchitis and Asthma.	Delirium.
Primary.....	18.5	10.5	2.6	0.7	0.6	1.7	0.3	0.6
Secondary.....	5.2	9.3	2.6	0.0	1.9	0.1	....	....
Disease.....	10.6	12.6	2.4	0.8	0.5	6.4	0.3	0.3
Total.....	34.3	32.4	7.6	1.5	3.0	8.2	0.6	0.9

The question which naturally arises from this analysis of the causes of death after amputation is one entitled to the most serious consideration. *Can this mortality be diminished?* The solution of this subject does not rest alone with the surgical staff of a hospital, but devolves with greater force on the management. The history of many of the German hospitals, and the experience in the Pennsylvania Hospital during the last few years, sufficiently demonstrate the feasibility of almost entirely eliminating pyæmia from the causes of death after amputation, and thereby saving, approximately at least, 32 per cent. of human life. Can a more cogent motive be presented for the introduction into our hospitals of every known improvement in ventilation and surgical dressings?

Special Amputations.

All amputations are done either in the continuity or in the contiguity of a limb. In speaking of special or individual amputations, I shall describe first those which are practiced in the upper extremity, beginning in each case with the distal portion of the limb.

AMPUTATIONS IN THE UPPER EXTREMITY.

Amputations of the Phalanges.—The ungual phalanges, though frequently the subjects both of disease and of injury, rarely require a formal amputation. When, in consequence of necrosis or crush, it becomes necessary to remove the bone, the operation should be confined to enucleating the phalanx, leaving the soft parts and the nail, which, though they may become somewhat misshapen, serve to prolong the finger and, in a great measure, to preserve its natural appearance.

When it is necessary to amputate as high as the intermediary phalanx, it is better to operate at the metacarpo-phalangeal articulation; for the subsequent approximation of the adjoining fingers will have scarcely any deformity, whereas if the first phalanx be allowed to remain, the stump becomes a very conspicuous and unsightly feature, and does not materially add to either the strength or the usefulness of the hand.

The exception which is made to this rule is in the case of the *index finger*, the smallest portion of which, in certain occupations, is of indispensable importance.

No part of the thumb should be sacrificed when its preservation is possible. The loss of this member, from its functional importance, is a serious calamity to the hand.

When the cause which necessitates the amputation of a phalanx does not extend far above the anterior articular end of the intermediary piece, the finger should be removed in its continuity above the disease or injury, the bone being severed either with a metacarpal saw or by the cutting pliers.

An amputation in the continuity of the intermediary phalanx is preferable to one at the proximal intermediary articulation, as in the former case the insertion of the short flexor tendon is preserved, and, consequently, the power of flexing the stump, whereas in the latter case that power is lost, or is only slightly preserved through the action of one of the lumbricales muscles.

Amputations in the contiguity of the digit are most satisfactorily executed by making a short dorsal flap, convex downward, and a long palmar one.

The position of the joint may be unfailingly recognized by remembering that when the digit is flexed the knuckle is the upper boundary of the articulation.

Amputation in the continuity may be performed by making either lateral or antero-posterior flaps. In all amputations in this part of the upper extremity, after the dressing of the wound, the hand should be placed on a palmar splint.

The knife best adapted for amputations of the phalanges is that of Professor Neill. It is a narrow, short-bladed, sharp-pointed bistoury, with a stout handle. (Fig. 1159.)

The difficulty usually experienced by an inexperienced operator in phalangeal amputations done in the contiguity may be referred to the strength of the

FIG. 1159.



Knife for amputating the fingers.

lateral ligaments of the joint, which, unless divided early, prevent the knife from entering the articulation, and to the peculiar conformation of the articulating extremities of the phalanges.

A study of Fig. 1160, representing the metacarpal bone with its three phalanges, will greatly facilitate these amputations.

FIG. 1160.



The lip which projects back from the proximal end of the intermediate and ungual phalanges, unless the joints are flexed, will prevent the knife from entering the articulation; and the fact that the condyles belonging to the proximal extremities of the phalanges extend beyond the centre of the joint shows the necessity of separating the latter by a curvilinear and not by a straight incision.

OPERATION.—The hand being placed in the prone position, an assistant

FIG. 1161.



Amputation of a finger.

holds the sound fingers out of the way by drawing them towards the palm, while the operator, grasping the finger to be removed between the thumb and the index finger of the other hand, flexes the joint, with the other hand an incision is made across the dorsal aspect of the finger, from the side of the joint to the other side convex downward. The rounded skin-flap being next dissected back, the joint is opened by strongly flexing the finger (Fig. 1161) and applying the edge of the knife to the back of the articulation. The next step consists in dividing the lateral ligament with the point of the bistoury, first on one side and then on the other, after which

the knife is passed between the articulating surfaces, and, being turned on its flat, is made to shave forward from the palmar surface of the finger a long flap, embracing all the tissues down to the bone. (Fig. 1162.)

The digital arteries, which are necessarily divided, rarely require to be ligated, and the stump is closed by bringing up the long anterior flap in front of the phalanx and joining it to the short posterior flap by means of three stitches.

second method of operation is to supinate the hand, and, while the fingers are flexed on the palm, the blade of the bistoury is pushed across the joint, and a long flap is carried, by a sawing motion, downward. The articulations next opened and the bones freed by dividing the lateral aspects on the same aspect of the hand and cutting (as the knife comes) on the dorsal surface of the hand, either a straight flap or, by turning the edge forward, a rounded integument.

Amputations of the phalanges of the thumb are to be performed in the same manner as those of the

carpo-phalangeal amputations.

The hand having been placed in one position and the sound hand drawn out of the way, the surgeon, grasping the injured or diseased member and placing the point of the bistoury directly in front of the middle of the knuckle, sinks the instrument once to the bone, and carries an incision first directly forward for a distance, and then, diverging to one side, passes through the interdigital space to the palm.

A similar cut is made on the opposite side, the two joining on the palmar aspect of the hand opposite the point of beginning. (Fig. 1163.) The flaps represent two V's, with their bases resting against each other. The flaps are now carried upward, keeping their edge close against the proximal phalanx and cutting into the side of the joint, the finger at the same time being carried strongly to the opposite side, in order to make the ligaments

FIG. 1162.



Cutting anterior flap in amputation of a finger.

FIG. 1163.



For metacarpo-phalangeal amputation.

FIG. 1164.



Knife passing through the metacarpo-phalangeal joint.

FIG. 1165.



Appearance of the wound after amputation at the metacarpo-phalangeal joint.

and the articulation to gape, so that the bistoury can be carried through the joint (Fig. 1164), to the opposite side. Then, as the blade emerges, the position of the finger must be reversed, and the operation completed by turning the knife down along the opposite side of the phalanx. (Fig. 1165.)

That the adjoining metacarpo-phalangeal articulations may come closely together and efface the chasm between the fingers, many advise the removal of the head of the exposed metacarpal bone with the cutting pliers. But as this enlargement atrophies in time, and as the operation exposes unnecessarily the cancellated structure of the bone, it is better that it should not be done.

There is a modification of this operation,—an amputation in which the incision on the palmar aspect of the joint, instead of being prolonged into the palm of the hand, is carried directly across in the crease which marks the junction of the finger and hand. The approximation of the wound, however, is never so neat by this plan as by the former method of operating.

One or two vessels usually require ligation after this amputation; after which the edges of the wound should be united by two or three stitches, the parts covered with a piece of lint moistened with carbolated oil, and a

still more accurate apposition effected by encircling the hand transversely with a roller bandage. The trifling deformity which follows the removal of a finger at this joint will be seen by reference to Fig. 1166.

Amputation of the thumb at the metacarpo-phalangeal articulation is executed by incisions similar to those made in like amputations of the fingers.

Amputations of the metacarpo-

phalangeal bones.—The removal of the whole or a part of the metacarpal bone, with its corresponding digit, may be required in consequence of injury, less frequently for disease.

When such a procedure becomes necessary, the operation is done by a dorsal incision, commencing at the carpal extremity of the metacarpal bone, and carried forward to its phalangeal extremity or to the knuckle. Beyond this the direction of the knife is changed, by leaving the middle line and passing gradually towards and through the interdigital cleft and web on one side into the palm, where it is to be joined to a similar cut on the opposite side, the two being counterparts of those made in metacarpo-phalangeal amputations.

The soft parts should now be dissected or crowded off from the dorsal and lateral surfaces of the metacarpal bone. Afterwards the ligaments uniting the anterior extremities of the latter with the adjoining bones are to be divided, when the finger, being drawn backward, will serve to raise the metacarpal piece from its bed, so as to admit of its being detached from the soft parts connected with its anterior surface.

The last step in the process is to effect the disjunction of the bone at its carpal articulation. As the deep vessels in the palm of the hand lie some upon and others between the metacarpal bones, great care must be taken to keep the edge of the knife in close contact with the bone. A probe-pointed bistoury constitutes the safest instrument for the deeper stages of the operation.

Cases of injury will be encountered where the damage is limited to the anterior extremity of the metacarpal bone, or to the articulating end of the latter and of its corresponding phalanx, in which resection can be practiced and the finger preserved.

Amputation of the thumb and metacarpal bone should be performed in such a manner as to preserve the entire mass of muscles forming the thenar part of the hand, in order that there may remain some opposing surface against which these fingers may act.

If the surface of the skin is examined at the metacarpal part of the hand, the line of junction between the palmar and dorsal surfaces of the skin can

FIG. 1166.



After amputation at the middle finger.

be clearly recognized by the contrast in the color of the two. This line, when the arm hangs in the natural position, is out of view or in shade, and is, on that account, to be selected as the line of incision, by which the resulting cicatrix will be concealed.

The junction of the metacarpal bone with the trapezium is situated one inch in front of the styloid process of the radius, and it is at this point that the incision should begin, following the line already mentioned, and extending forward almost to the metacarpo-phalangeal joint, where it should diverge towards the index finger, passing through the intermediate web, and terminating on the palmar or opposite surface of the articulation. This is joined by a second incision, beginning at the point of divergence of the first and passing to the opposite side of the articulation. (Fig. 1167.)

The muscles must now be dissected away from the bone, and the three extensor tendons divided at the base of the first phalanx. The remaining part of the operation can be readily executed by using the thumb as a lever, dragging

FIG. 1167.



Line of incision in removing the thumb with its metacarpal bone.

FIG. 1168.



Dividing deep attachments of the metacarpal bone.

it towards the radial side of the arm or away from the index finger, dividing the deeper connections of the metacarpal bone backward towards the carpus, and finally effecting its disarticulation. (Fig. 1168.)

If the knife has been kept close against the bone, there will be very little bleeding. The vessels being tied, and the sides of the wound brought together with three or four interrupted sutures, the remaining part of the dressing should be the same as in other amputations in this part of the hand. However successful may be the cure, the loss of the thumb robs the hand of its beauty, force, and grace. (Fig. 1169.)

The little finger can be removed by similar incisions made along the line of junction between the palmar and dorsal skin on the ulnar side of the hand, and by two diverging cuts, starting from the first, including the metacarpo-phalangeal articulation, and going in front.

Amputation of the metacarpal bones of the four fingers.—Placing the hand in a state of extreme supination, enter the knife on the palmar aspect of the hand opposite the articulation of the metacarpal bone of the little finger with the ulnar bone, and, pushing it across between the bones and the soft parts, bring its point out immediately below the thumb; carry the knife downward close in contact with the metacarpal bones, and cut out, forming an elliptical flap. (Fig. 1170.) Then, turning the hand in the position

of pronation, make a semicircular incision across its dorsal surface, three-quarters of an inch below the carpo-metacarpal articulation, joining this in-

FIG. 1169.



Hand after amputation of the thumb
and metacarpal bone.

FIG. 1170.



Amputation of the metacarpal bones
of the four fingers.

cision with the anterior one at both the inner and outer margins of the hand. It only remains now to disarticulate the different metacarpal pieces from the metacarpus, beginning at the index or the little finger, according as the hand operated on is the right or left one, and preferably from the palmar side.

The manifold injuries to which the hand is exposed, particularly from machinery and shot wounds, render it impossible to anticipate and describe the details of every amputation which may be required in individual cases. There are, however, certain general rules which will serve to regulate the conduct of the surgeon when he comes to deal with these accidents, and they may be formulated as follows:

1. Perform no amputation when there is the faintest probability of saving the damaged part.
2. Sacrifice no more than is absolutely necessary when an operation is unavoidable.
3. Use the skin from a finger which may be hopelessly damaged and which will require amputation to cover one whose skeleton and vessels remain sound, though its tegumentary covering may be destroyed.

STATISTICS.—The mortality following amputation through the phalangeal and metacarpal portions of the hand is very low. In the Surgical History of the War there are 7902 cases of these amputations tabulated, with 223 deaths, or, more strictly, 204 deaths, as among the fatal cases there are 19 recorded from subsequent amputation performed higher up.

Amputation of the Hand at the Wrist.—Surgeons are not entirely in accord as to the relative value of amputations through the wrist-joint and of those executed immediately above it. The advantages claimed for the first are the increased length of the lever and the preservation of the movements of pronation and supination. These are substantial reasons and deserve consideration. Not invariably, however, are these motions retained. The absence of the carpus is often, if not indeed always, followed by a degeneration of the inferior radio-ulnar articulation and by the production of a dense band of fibrous tissue, which, by ankylosis, practically destroys pronation and supination. In a case of wrist-joint amputation which was done at Guy's Hospital by Mr. Cock, an opportunity was offered of dissecting the stump sixteen

years after the operation. The synovial sac between the radius and ulna had not been opened when the amputation was performed, and yet the movements of pronation and supination were entirely lost in consequence of ankylosis.

That which should determine the choice between the two operations is their respective mortality. We are not in possession of a sufficient number of wrist-joint amputations performed in civil surgery from which to deduce any reliable conclusions, but the annals of military surgery supply a considerable amount of data. The following results, gleaned from military surgery, will throw some light on the subject:

In the Crimean War 3 successful cases of this amputation were reported.

Chenu,* in his Report of the Campaign in the East, 1865, gives 68 cases of wrist-joint amputations, with 27 deaths. The same writer, in his Statistics† drawn from the Italian Campaign in 1869, supplies 13 cases, with 6 deaths.

Demme‡ tabulates 12 cases, with 5 deaths; Loeffler§ mentions 1 case, with 1 death; Biefel|| reports 3 successful cases, and Ferand 1 successful case. Arnaud also gives 3 cures.

Chenu analyzes 101 wrist amputations, with 69 deaths, or a death-rate of 68.22 per cent. Beck¶ gives 2 cases, with one death, and MacCormac** 2 cases, with 2 successes.

Dr. S. W. Gross has tabulated 146 cases of amputation at the wrist-joint, of which number 100 recovered from the operation and 46 died,—a death-rate of 31.5 per cent.

During the American civil war 68 wrist-joint amputations were reported, with 7 deaths,—a mortality of 10.6 per cent. Of the entire number, 55 were primary, with 5 deaths, or 9.2 per cent. mortality; 7 were intermediary, with 1 death, or 14.3 per cent. mortality; and 5 were secondary, with 3 recoveries, 1 death, and 1 result undetermined.

Summing up all the cases mentioned, other than those of Dr. Gross and Dr. Otis, we have 209, with 74 deaths,—a mortality of 35.4 per cent. This percentage slightly exceeds that deduced from Dr. Gross's data, and is far above the death-rates given by Dr. Otis.

OPERATION.—The operation will be facilitated by recalling the leading features of the joint. The articulating surface of the radius and the triangular cartilage as it rests against the ulna is concave, the styloid processes of the radius and the ulna forming respectively the inner and outer boundaries of the carpal arch. The three bones of the first row of the carpus, consisting of the scaphoid, semilunar, and cuneiform, are arranged so as to present a convex surface adapted to the concavity of the bones of the arm. (Fig. 1171.)

In performing the operation, two semilunar flaps should be raised, one from the posterior and the other from the anterior aspect of the wrist and hand,—the latter somewhat the longer of the two. (Fig. 1172.) For this purpose the hand should be held in the prone position and somewhat flexed, while the surgeon carries an incision down to the bones and across the back of the wrist, from one styloid process to the other, cutting a flap convex downward and one inch and a half in length. This flap should now be raised and the posterior radio-carpal ligament incised while the hand is strongly flexed. By reference to Fig. 1172 it will be seen that in opening the back of the joint the point of the knife must be applied some distance above the plane of the styloid processes. If this direction be not observed, the operator will, in all probability, open the articulation between two rows of the carpus.

The joint being exposed, the knife, following the arched form of the

* Rapport, etc., pendant la Campagne d'Orient, 1865, p. 641.

† Statistique, etc., de la Campagne d'Italie, 1869, p. 641.

‡ Mil.-Chir. Studien, 1861, B. ii. S. 241.

§ General Bericht, 1867, S. 301.

|| Langenbeck, 1869, B. xi. S. 475.

¶ Chirurgie d. Schussverletzungen, 1872, S. 1842.

** Notes and Reflections of an Ambulance Surgeon, London, 1871, p. 130.

carpus, is next applied to the lateral ligaments, the severing of which is followed by the separation of the articulating surfaces sufficiently to admit

FIG. 1171.



Radio-carpal articulation.

FIG. 1172.



Lines of incision in amputation at the wrist.

of the knife being carried through the joint (Fig. 1173) and made to shave the anterior or palmar flap, by cutting from above downward and outward. This flap, comprising a portion of the dense tissue of the palm of the hand, should be longer than its fellow, so as to have a surface at the end of the stump adapted to endure pressure.

FIG. 1173.



Knife carried through the wrist-joint preparatory to cutting the palmar flap.

In making this anterior flap, the surgeon should be careful to pass through the articulation of the pisiform with the cuneiform bone, including the former in the flap, and thereby preserving the insertion of the flexor carpi ulnaris muscle. The styloid processes of the radius and the ulna are next to be sawed off on a level with the cartilaginous surface of the joint, thus making the surface of the stump uniform.

In cutting off the styloid process of the ulna, only the top should be removed. If the saw is applied too near the base, the triangular interarticular cartilage is liable to be detached and the radio-ulnar sac opened, which will disturb the relation of the bones.

The radial, ulnar, and interosseous arteries, with their branches, being tied, the long anterior flap is brought up in front of the bones, and stitched, by interrupted sutures, to the short posterior flap. The usual dressings are then applied.

Other modes than the one described have been employed for this amputation, as the *circular* and the *single anterior flap*, as practiced by Guérin.

In adapting an artificial hand to the stump after amputation at the wrist-joint, it is necessary to wear a sheath on the forearm and arm (Figs. 1174,

FIG. 1174.



Artificial arm and hand.

FIG. 1175.



Hand detached, and nipper at end of arm.

FIG. 1176.



1175, 1176), to the end of which the hand may be attached, or from which it may be removed at pleasure. The last figure represents a little mechanism at

the end of the arm-piece, called "*the nipper*," which can be made to open or close by a motion imparted from the arm. By the aid of this ingenious addition there are women in Philadelphia who are enabled to sustain themselves by needle-work, who would otherwise be entirely dependent. This artificial arm is also adapted to all cases of amputation of the forearm.

Amputation of the Forearm.

The forearm may be amputated at any point between the wrist and the elbow. But when the surgeon has an election, the removal should be made as low down as possible. In planning an amputation at the carpal extremity of the forearm, the insertion of the supinator brevis muscle should be preserved, when feasible; and in operating above the middle, the insertion of the pronator radii teres should not be disturbed. In the first instance the movement of supination will be retained, and in the last the function of pronation will remain.

Abscess after amputation at the *lower third* of the forearm is more common than in any other portion of the member, probably in consequence of the numerous tendons, with their cellular investments, offering spaces for the retention of inflammatory products.

At the *lower third* of the forearm, no method of amputation is superior to that by antero-posterior oval tegumentary flaps, or the modification of this plan with the oblique division of the muscles suggested by the author and illustrated on page 305, Fig. 1133.

In performing the oval tegumentary flap amputation, the tourniquet should be placed over the brachial artery at the middle of the arm, so as to control the circulation. The forearm is then held midway between pronation and supination, while the operator makes two semilunar incisions, one in front and the other on the back of the member, extending between the radial and ulnar borders of the limb, and carried down to the deep fascia. These flaps being dissected up and reverted to an extent necessary to cover easily the ends of the bones, the muscles are next divided down to the bones by a continuous circular sweep of the knife. The interosseous structures are severed by pushing the catling between the radius and ulna and carrying it around each bone separately. The soft parts being now protected by the retractor, the bones are divided with the saw.

The arteries requiring ligation are the radial, the ulnar, the interosseous, and, perhaps, two or three muscular branches.

Amputation at the middle and at the upper third.—The musculo-tegumentary flap method is to be preferred at these localities. The proximity of the bones to the soft parts on the posterior aspect of the arm renders it somewhat difficult to cut by transfixing a flap from the entire transverse extent of the arm, on which account the incision may be made from without inward.

OPERATION.—The arm being held midway between pronation and supination, a rounded or semilunar incision is made across the posterior surface of the forearm down to the bones, and extending from the ulnar to the radial border. The flap, which must include the integument and muscles, is next dissected up a sufficient distance and reflected. The anterior flap is now formed by pushing the knife across the front of the bones from the angle of the first incision

FIG. 1177.



Amputation at the middle of the forearm by the musculo-tegumentary flap method.

on one side to that on the other (Fig. 1177), and cutting downward and outward with a sawing motion. An assistant grasping the two flaps and holding them back, the surgeon completes the operation by dividing the interosseous structures with the catling, and sawing off the bones.

The vessels requiring ligation are the same as in amputation at the lower third of the limb.

Amputation at the upper third of the forearm is executed in the same manner as at the middle third. (Fig. 1178.)

FIG. 1178.



Amputation at the upper third of the forearm.

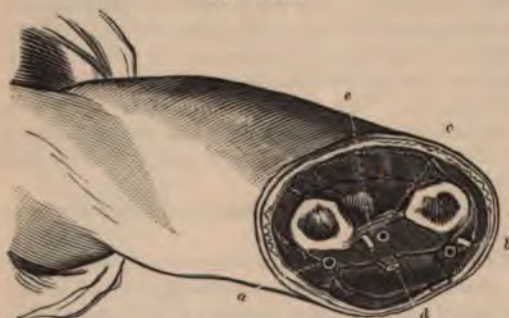
The relation of the arteries and nerves to the muscles, and the appearance of the muscles as encased in their sheaths, can be very well studied in a transverse section of the forearm, as represented in Fig. 1179, copied from the cadaver.

The mortality following amputation of the forearm in civil hospitals is about 13.76 per cent., while in

American military hospitals during the late war it was almost the same,—13.9 per cent.

Amputation at the Elbow-Joint.—Amputation at the elbow-joint should always be adopted when the alternative is either to disarticulate or to cut off the arm above. The healing progresses even more rapidly than in operations done in the continuity of the arm; the stump presents as shapely an appearance as could be desired; and there is certainly less constitutional perturbation than is experienced in amputations immediately below the joint.

FIG. 1179.



Section showing arteries, nerves, and muscles of the forearm: a, radial artery; b, ulnar artery and nerve; c, interosseous artery; d, median nerve; e, interosseous nerve.

The operation is an old one, having been, it is believed, first performed by Ambrose Paré, in 1536, in the case of a shot wound in the forearm of a soldier at Turin, the patient

making a good recovery. This amputation does not, however, seem to have attracted professional notice, as, with the exception of a single recorded case, nothing was heard of it until revived in Germany by Textor in 1819 and by Dupuytren in France in 1839, the last-named surgeon having performed the operation, it is alleged, with very marked success in seven or eight instances. The first case of this operation performed in America is attributed to an army surgeon, Dr. Mann,* in 1822. Dr. J. Kearney Rodgers reported a case† in 1828. The operation early received the sanction of Liston, who speaks of having done it two or three times.‡ With the exception of Chenu's statistics, the results of this amputation, as collected from foreign sources, have been very favorable, the death-rate not exceeding 14 per cent. The latter-named writer, however, from some inexplicable causes, in a collection of 217

* Medical Repository, vol. vii.

† New York Medical and Physical Journal, vol. ii., 1828.

‡ Liston's Practical Surgery, 1840, 3d edition.

cases of amputation at the elbow-joint, gives a mortality of over 65 per cent. During the War of the Rebellion 49 cases of this operation were reported, with 43 recoveries, 5 deaths, and 1 undetermined result. Of 4 amputations at the elbow-joint performed at the Pennsylvania Hospital, all recovered. Of 7 similar amputations at Guy's Hospital, London, 6 were cured; and of 6 done at St. Thomas's Hospital, London, 4 recovered. In an aggregate of 1114 amputations of all kinds performed during the last ninety-nine years in the Parisian hospitals, there were only 4 at the elbow, with what result is not stated.*

OPERATION.—The most satisfactory operation, and at the same time that most easily executed, is one in which the stump is covered by a long anterior musculo-tegumentary flap, taken from the front of the arm. In doing this, the knife is introduced three-quarters of an inch below the internal condyle of the humerus, and pushed directly across the front of the arm, bringing it out on the opposite side the same distance below the external condyle.

During the act of transfixing, the forearm should be supinated and flexed to an angle of thirty-five degrees: the object of this is to cause the anterior ligament of the joint to start forward, so that it shall be divided, and the articulation opened, as the knife crosses the front of the joint.

The transfixion being effected, a musculo-tegumentary flap, four or five inches in length, must be shaved from the bones of the forearm. This should be completed by cutting quite abruptly out to the surface, thus forming a rectangular instead of a rounded termination to the flap (Fig. 1180), by which the broad surface of the stump can be satisfactorily covered. A second incision is now made directly across the back of the joint down to the bone, from one side of the first wound to the other. After this the knife should be passed between the head of the radius and the humerus, and from thence

FIG. 1180.



Anterior musculo-tegumentary flap, and the anterior ligaments cut from the front of the elbow-joint, exposing the radius and ulna.

across the front of the joint, between the coronoid process and the humerus; this movement must terminate by cutting the internal lateral ligament, when the articulating surfaces of the elbow will fall asunder. The operation is completed by sawing through the olecranon immediately above the coronoid process, and from before backward, thus leaving the first-named process attached to the tendon of the triceps muscle.

The radial, ulnar, and interosseous arteries will require to be tied; after which the long anterior flap must be carried round the articulating end of the humerus, and united to the edge of the posterior flap by sutures.

The exarticulation is sometimes effected by the circular and also by the lateral flap method, both of which are inferior to the one described.

* Half-Yearly Abstract of Medical Sciences, vol. xxxvi. p. 197.

Amputation of the Arm.

Amputation of the arm may be performed by any of the methods which have been described,—namely, by the circular or oval tegumentary flaps, by the Teale plan, or by musculo-tegumentary flaps. The latter is the one generally practiced by Philadelphia surgeons. The only objection which can be urged against this last plan (especially when applied to the lower and the middle third of the arm, where the biceps muscle is so movable) is the very unequal retraction of the integument and the muscles, the latter generally hanging down some distance below the former after their division. It is for this reason that I prefer the mixed method, which I have described on page 305, in which antero-posterior oval skin flaps are raised, just sufficient to compensate for the difference in cutaneous and muscular retraction, and after dissecting up these flaps antero-posterior muscular flaps are formed, either by transfixion or by cutting from without inward, always terminating or commencing the incision, according to the course preferred, on a level with the base of the reflected tegumental flaps.

Applying the tourniquet.—In applying the tourniquet in amputations through the lower or middle third of the arm, the instrument must be placed along the inner edge of the biceps or the coraco-brachialis muscle, the brachial artery being placed in this situation. When, however, the removal has to be undertaken high up in the upper third, the circulation will have to be controlled by making a few turns of a two-inch bandage through the axilla and over the shoulder, placing the body of the roller longitudinally in the axilla over the artery, against which it can be sufficiently pressed by the strap of the tourniquet, the base of the latter being planted upon the shoulder close to the neck. An assistant may also, if it be necessary, press the subclavian against the first rib with the handle of a door-key, as explained under the head of hemorrhage, vol. i. page 160. The subclavian may also be compressed by placing a graduated compress in the hollow above the clavicle and forcing it upon the vessel by means of the elastic bandage passed across the shoulder and the opposite axilla.

OPERATION.—If the ordinary plan of executing the musculo-tegumentary operation is adopted, the flaps (each of which ought to be from two and a half to three inches in length, according to the size of the arm) should be, as in the preceding plan, cut from the anterior and posterior aspects of the arm, the former, containing as it does the brachial blood-vessels, being formed last.

Pinching up from the bone all the soft parts, consisting of the skin, fascia, and triceps muscle, the knife is pushed through behind the humerus from one side of the arm to the other, and a rounded flap is cut from above downward. The section being completed, and the divided parts held back by an assistant, the anterior flap is next formed by transfixing and cutting downward and forward (Fig. 1181) the soft parts in front of the humerus,

FIG. 1181.



Amputation of the arm by the musculo-tegumentary flap method.

FIG. 1182.



Appearance of the stump.

including the integument, fascia, biceps and brachialis anticus muscles, blood-vessels, and nerves. The assistant retracting both flaps, the knife is carried rapidly around the bone at their base, dividing the structures which

may have escaped the previous incisions. The amputation is completed by sawing off the humerus, leaving a deep Λ -shaped wound. (Fig. 1182.) It is rarely necessary to apply a retractor in this operation.

The arteries demanding ligation are the brachial, the anastomotie, and the superior and inferior profunda.

The relation of the blood-vessels, nerves, and muscles is shown in Fig. 1183.

After the healing is completed, a very excellent and well-fashioned stump usually remains. (Fig. 1184.)

FIG. 1183.



Relation of the anatomical components of a stump after amputation through the middle of the arm; a, brachial artery; b, median nerve; c, superior profunda artery.

FIG. 1184.



Stump after amputation of the arm by the musculo-tegumentary flap method.

In amputations of the arm, either for disease or injury, the insertion of the deltoid, if possible, should not be disturbed, as this muscle executes a very important movement,—that of elevating the arm.

Amputation by the rectangular or Teale method may also be employed in the removal of the arm.

The lines of incision for securing the long anterior flap must be made in such a manner that the inner one shall be sufficiently near to the margin of the biceps muscle not to involve the brachial artery. (Fig. 1185.) The short

FIG. 1185.



Lines of incision for Teale's amputation at the lower third of the humerus.

flap is taken from the posterior aspect of the limb. After forming the flaps and cutting off the bone, the adjustment is made as shown in Fig. 1186.

The mortality following amputation of the arm in civil practice is a fraction

over 23.61 per cent. This calculation is based on an aggregate of 14,366 cases. (See Tables of Amputations.) In military practice, the death-rate,

FIG. 1186.



Flaps adjusted in Teale's amputation of the arm.

FIG. 1187.



Artificial arm for amputation above the elbow-joint.

estimated from a total of 5273 amputations performed on account of shot injuries, was 23.6 per cent.

The statement that the mortality of amputations increases in a steady ratio as the trunk is approached, which is generally accepted as true, requires to be somewhat modified when applied to the removal of the upper arm, if Dr. Otis's figures are conclusive.* For example, it appears that in 1952 amputations, primary, intermediary, secondary, and undesignated, done in the upper third of the arm, the death-rate was 18 per cent.; in the middle third, 1739 amputations, belonging to the same periods, gave a mortality slightly exceeding 16 per cent.; while in the lower third, 758 amputations yielded a death-rate of 26 per cent. The explanation, I think, is not to be found in any anatomical peculiarities of the lower third of the arm, but rather in the participation of its structures in the violence done to the elbow-joint, on account of which the amputation was rendered necessary. In civil practice the results will, I am confident, be found different.

An artificial arm can be worn after amputations above the elbow-joint, and, though capable of being made useful in certain prehensile acts, is chiefly valuable for purposes of dress. (Fig. 1187.)

Amputation through the Shoulder-Joint.

The exarticulation of the arm may be effected in several ways. The most popular methods are those of Larrey, Dupuytren, Lisfranc, and Spence.

FIG. 1188.



Larrey's method of amputation at the shoulder-joint.

LARREY'S, OR THE OVAL METHOD.—This, of the four named operations, is the most easily executed, and yields results as satisfactory as any other.

The arm being held a short distance from the body, a longitudinal incision is made down to the bone, over the middle of the deltoid muscle, commencing at the acromion process and extending downward two inches and three-quarters. From the lower extremity of this incision two others are prolonged,—the one passing in a gentle curve downward and backward, and the other in like manner downward and forward, both stopping short of the main blood-vessels and leaving the soft parts on the inner aspect of the arm undivided. (Fig. 1188.)

These oval flaps are next dissected forward and backward until the head

* Surgical History of the War, vol. ii. p. 805.

of the bone covered by its capsular ligament is seen. The surgeon now grasps the arm and carries it to the side of the body, while the capsule of the joint is freely incised in a transverse direction, exposing the head of the humerus.

The next step consists in cutting the tendons of the scapular muscles, which are inserted in the tuberosities of the humerus. This is most effectually done by the operator grasping the arm with one hand and forcibly rotating the head of the humerus, first inward, so as to make tense the tendons of the supra-spinatus, infra-spinatus, and teres minor muscles, while with the other hand their tendons are divided by the knife.

After the division, the arm is next to be rotated outward, and the tendon of the biceps muscle severed, and also that of the subscapularis from its connection with the greater tuberosity of the bone. The arm is now to be carried backward and towards the side, in order to direct the head of the bone away from the glenoid cavity of the scapula when the knife is carried in between the latter and the neck of the humerus, preparatory to dividing the tissues on the inner surface of the arm.

An assistant, leaning over the shoulder of the patient, now seizes the posterior flap between the thumbs and fingers of his two hands, following closely the descent of the knife, in order to grasp the axillary vessels as the surgeon completes his inner incision. (Fig. 1189.) If attention is given to these details, the time required for the amputation is very short.

Should the humerus happen to be broken near to or at the surgical neck, the operation is rendered more tedious from an inability to utilize the bone as a lever. In such cases I have found the exarticulation expedited by seizing the upper short fragment with a pair of strong lion forceps, by which the piece can be manipulated at pleasure.

The axillary, circumflex, and other vessels being tied, the flaps are to be brought together and retained in place by a number of interrupted sutures. The line of approximation will be vertical, and the stump when healed somewhat wedge-shaped. (Fig. 1190.)

DEPUYTREN'S OPERATION, in which two rounded flaps are taken from the outer and inner aspects of the arm, may be executed quite as rapidly as Larrey's. The arm being carried off at a right angle with the body, in order to relax the deltoid muscle, while the patient is in a semi-recumbent position, the surgeon pinches up the thick cushion of flesh overlying the shoulder, and, introducing the point of a narrow-bladed knife two inches posterior to the acromion process, pushes it directly across the front of the joint, shaving as it advances the capsular ligament, and brings it out a little external to the coracoid process of the scapula.

The transfixion being accomplished, the knife is made to follow the surface

FIG. 1189.



Knife dividing the tissues on the inside of the arm, and the thumbs in position in order to seize the axillary vessels.

FIG. 1190.



Appearance of the stump after amputation at the shoulder-joint. From a patient in the Pennsylvania Hospital.

of the bone and to cut a rounded flap which shall terminate immediately above the insertion of the deltoid muscle, and which is to be turned up and held out of the way by an assistant.

The surgeon next draws the arm inward and backward, making the head of the bone prominent, and proceeds to divide the capsular ligament. He afterwards severs the tendons of the biceps and scapular muscles: this will be facilitated by internal and external rotation of the arm, as in the Larrey method.

The bone being now displaced from its socket, the knife is passed across its inner surface, and the internal flap formed by dividing all the structures on this aspect of the arm, terminating the cut in a rounded manner at the point where the folds of the axilla join, and controlling the axillary vessels by

FIG. 1191.



Stump after Dupuytren's amputation at the shoulder-joint.

the thumbs and fingers following the descent of the knife, as explained in the previous operation. The approximation of the flaps in the Dupuytren operation gives a transverse cicatrix (Fig. 1191), instead of a vertical one, as in that of Larrey.

LISFRANC'S OPERATION requires for its performance a very thorough knowledge of those movements of the scapulo-humeral articulation which allow of the largest space between the acromion and the head of the humerus. Unless these are distinctly understood, the knife will get locked and its movement will be embarrassed. The operation has never been popular in America.

If the amputation is to be performed on the *left* shoulder, the knife is entered near the posterior fold of the axilla, and carried across the joint, between the acromion and the head of the humerus, emerging between the coracoid process and the clavicle, the arm at the same time being held by an assistant in the position of abduction. (Fig. 1192.) Pinching up the mass of the deltoid, the surgeon carefully conducts the knife downward over the head of the humerus, and completes the incision by cutting a flap four and a half or five inches long.

If this part of the operation has been executed correctly, the capsular ligament will have been opened and the tendon of the supra-

FIG. 1192.



Lisfranc's method of amputating at the shoulder.

scapular and the long head of the biceps muscle divided.

The anterior flap being held out of the way by an assistant, the second part of the procedure is accomplished by adducting the arm, carrying the elbow in front of the chest, and, after passing the knife through the articulation, dividing the tendons of the subscapularis, infra-spinatus, and teres major muscles, and cutting the inner flap from within outward. During the last-named movement of the knife, the same provision is

made to grasp the vessels as in the other operations.

When the operation is done on the *right* side, unless the operator is ambidexter, the direction of the knife in transfixion will require to be changed;

that is, it will have to be passed in the reverse direction from that in which it is used in the left.

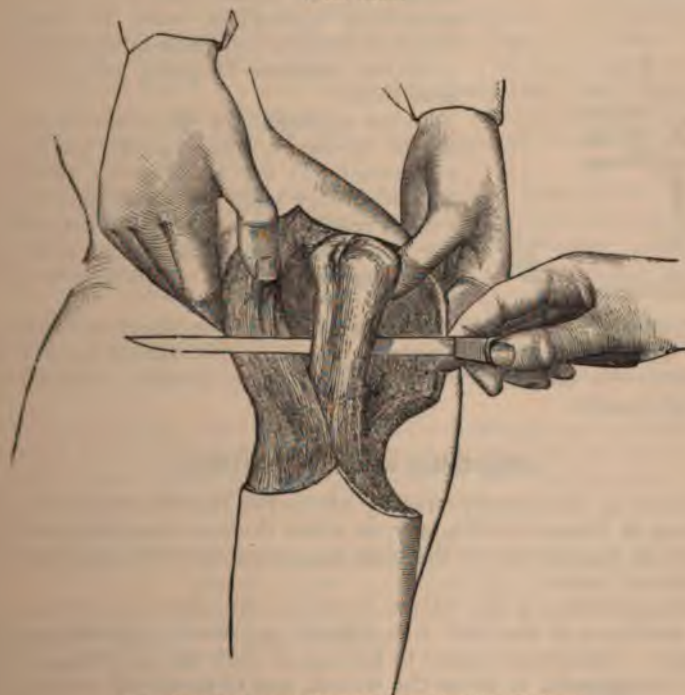
SPENCE'S OPERATION.—Professor Spence employs a method which he regards as possessing advantages over all others in several particulars,—namely, in securing a more shapely stump, in cutting the small branches of the circumflex artery instead of the large ones, and in the facility with which the disarticulation can be effected.

In this operation the incisions are not unlike those in Larrey's, except that the perpendicular one is made on the inner instead of on the outer aspect of the joint, and immediately external to the coracoid process, dividing the clavicular fibres of the deltoid and pectoralis major muscles as well as the humeral insertion of the latter.

From the lower end of the perpendicular incision a second cut is carried, with a gradual curve, across the outer surface of the arm, dividing the fibres of the deltoid muscle, and terminating at the posterior border of the axilla.

A third cut, beginning at the junction of the first and second, is next made across the inner side of the arm, not penetrating deeper than the superficial fascia, and extending through the axilla to join the second incision. (Fig. 1193.) If the fibres of the deltoid muscle have been divided down to the

FIG. 1193.



Spence's plan of amputating at the shoulder-joint (Erichsen).

bone, the anterior and outer flap containing the circumflex artery can now be readily raised with the aid of a finger and turned back, so as to expose the articulation and admit of the division of the capsular ligament, the long head of the biceps, and the tendons of the muscles attached to the tuberosities of the bone: the remaining structures can then be divided on the axillary side of the arm.

I cannot see that the advantages claimed for the operation of Professor Spence entitle it to any higher consideration than that attaching to the plans of Larrey and Dupuytren.

The most convenient mode of retaining the dressings to a shoulder-joint stump is by the use of a roller applied as a spica of the shoulder.

References are made to amputation at the shoulder-joint on account of gangrene by Hippocrates, Galen, and other ancient surgeons. But there is no evidence that the operation had been performed earlier than 1686, when La Roque claims to have removed the arm of a boy at the shoulder articulation in consequence of gangrene. Morand, in 1768, claimed for his father priority in this amputation,—a claim which is corroborated by La Faye in 1750. Le Dran, in his "Surgical Observations," states that his father successfully removed, in 1715, the arm at the shoulder-joint on account of disease. The first recorded instance of this operation for shot injury is one by Ravaton, in 1734. In this country, the earliest amputation of the kind was done by Dr. John Warren, in 1781, at the Military Hospital in Boston.

Amputation at the shoulder-joint is generally a very successful operation. After the battles of Wagram and Essling, Larrey amputated at the shoulder-joint 14 times, with only 2 deaths. In his final summary of operations at this articulation, this eminent surgeon records, in a total exceeding 100 cases, less than 9 deaths. These results are in singular contrast with those obtained by Guthrie and Smith. Guthrie records 38 cases of humeral

exarticulation on account of gunshot wounds, embracing an equal number of primary and secondary operations, with 16 deaths. Dr. Stephen Smith's collection of shoulder-joint amputations includes 71 cases, with 34 fatal terminations.

In an aggregate of 852 cases of this amputation (primary, intermediate, secondary, and undetermined) for shot injury, tabulated by Dr. Otis, there were 591 recoveries, 236 deaths, and 25 results unknown, or a mortality of 28.5 per cent,—a fatality about the same as that following amputations of the arm in civil practice.

Notwithstanding the short stump which follows amputation at the shoulder-joint, an artificial member can be worn (Fig. 1194), which, for parade purposes at least, is fairly serviceable.

FIG. 1194.



Artificial limb applied after amputation at the shoulder-joint.

Artificial member can be worn (Fig. 1194), which, for parade purposes at least, is fairly serviceable.

Amputation above the Shoulder.

Amputation of the upper extremity above the scapula may be required in consequence of disease or of injury, as when the arm has been torn off from the scapula by machinery, or has been left connected with the body only by a few shreds of tissue.

When an operation of this nature becomes necessary, on account of lacerations or avulsions of the limb, it is difficult to prescribe specific rules for its performance. The great objects to be kept in view are to obtain a sufficient amount of integument to cover the wound, and to secure all vessels likely to bleed.

When the arm has been torn off at the joint, the skin covering the shoulder is generally stripped off, or torn into narrow, ribbon-like flaps, and hence the necessity for occasionally dissecting out the scapula to secure a flap for the stump. In doing this, the knife must be kept closely applied to the bone, or the muscular attachments may be separated by an elevator, as in subperiosteal excision, with a view to avoid hemorrhage.

During the removal, hot water may be applied to the wound to arrest oozing, and any vessels that are not controlled by this measure should be tied as the operator proceeds.

When the amputation is a formal one, or is executed for disease, as sarcoma

or carcinoma, the same incisions as those described (page 249) for excisions of the scapula, or of the clavicle and scapula, will answer the purpose.

RESULTS.—The history of avulsions of the upper extremity is exceedingly interesting, from the fact that, notwithstanding the terrible nature of the mutilation and the violence producing it, the patients have all recovered. Of 14 recorded cases, in which the arm, the scapula, and, in most of the instances, a part of the clavicle have been torn off from the body, all recovered.

*Cases of Avulsion of the Arm, the Scapula, and part of the Clavicle.**

1. Cheselden,	1737.	Recovered.	8. Cooper.		Recovered.
2. Clooth,	1779.	"	9. King,	1845.	"
3. Mussey,	1819.	"	10. Cartwright.		"
4. James,	1830.	"	11. Horlbeck.	1859.	"
5. Scarnell,	1832.	"	12. Lowe,	1866.	"
6. Braithwaite,	1833.	"	13. Charles,	1872.	"
7. Lizars.		"	14. Katholitzky,	1879.	"

With the exception of one case, scarcely any blood was lost, and in most of the operations very little pain was experienced, which, taken in connection with the instantaneous nature of the occurrence, will probably explain the transient character of the shock and the early reaction which followed.

Every year of hospital experience strengthens my conviction that a great deal more blood is lost in those accidents which demand amputation than is generally supposed, and that this loss constitutes the prime factor of much of the fatal shock which is witnessed. It would be an important step towards the preservation of life if it were made compulsory that the superintendents of all manufacturing establishments and the conductors of railroad-cars should be instructed in the use of the tourniquet, and that such instruments should be kept always on hand.

Notwithstanding that there may be no bleeding immediately after avulsion of the upper extremity, the lacerated vessels should be sought for and tied, for there is always danger of hemorrhage when reaction sets in. The patient is also exposed to the risk of secondary bleeding, after the lapse of seven or fourteen days, especially should sloughing occur.

In dressing the wound at the time of the injury, any loose strips of integument which may be present should be utilized in covering a part of the raw surface; provided this can be done without producing too much tension of the skin.

The principal healing must be accomplished through open granulation.

Twenty-six amputations of the arm, with a part or the whole of the scapula, and in some instances with a portion of the clavicle, have been reported. Of this number, 15 recovered and 11 died.

Cases of Amputation of the Arm with the whole of the Scapula, and with or without a part of the Clavicle.

No.	Operator.	Date.	Disease or Injury.		
1	Cummins.	1808.	Shot wound.	.....	Died.
2	Gastani Bey.	1830.	Shot wound.	Recovered.	
3	Crueby.	1836.	Osteosarcoma.	.....	Died 6 months after operation.
4	Twitchell.	1838.	Malignant disease.	.....	Died.
5	Larrey.	1838.	Gunshot injury.	Recovered.	
6	Mussey.	1845.	Osteoid cancer.	Recovered.	
7	Lewis.	1845.	Machinery accident.	.....	Died on account of other injuries.
8	McClellan.	1848.	Encephaloid growth.	.....	Died 6 months after from return of disease.
9	Slopes.	1860.	Machinery accident.	Recovered.	
10	Langenbeck.	1862.	Disease.	.....	Died 18 months after.
11	I. C. Whishaw.	1862.		Recovered.	
12	Syme.	1863.		Recovered.	

* Edinburgh Medical Journal, vol. xv. Part I.; Lancet, Feb. 17, 1872.

Cases of Amputation of the Arm (continued).

No.	Operator.	Date.	Disease or Injury.		
13	Fergusson.	1867.	Tumor.	.....	Died.
14	Vincent Jackson.	1868.		.....	Died.
15	F. H. Watson.	1869.	Machinery accident.	Recovered.	
16	K. McLeod.	1869.	Disease.	.....	Died.
17	Jessop.	1874.	Injury.	Recovered.	
18	Parise.	1874.	Cancer.	.....	Died from recurrence of disease.
19	Parise.	1874.	Injury.	Recovered.	
20	Parise.	1874.	Injury.	Recovered.	
21	Esmarch.	1875.		Recovered.	
22	T. J. Young.	1875.	Railroad injury.	Recovered.	
23	B. B. Ross.	1876.	Avulsion of arm at the shoulder.	Recovered.	
24	Grady.	1878.	Disease.	Recovered.	
25	F. Gundrum.	1878.	Gunshot.	Recovered.	
26	Hunter.	1879.	Machinery accident.	.....	Died.
26				15	11

AMPUTATIONS IN THE LOWER EXTREMITY.

These amputations may be divided into those of the *foot*, the *leg*, and the *thigh*.

AMPUTATIONS OF THE FOOT include those of the *phalanges*, of the *metatarsus*, and of the *tarsus*.

Phalangeal Amputations.—Except in the case of the great toe, amputations are rarely done in either the continuity or the contiguity of the phalanges. It is better, when from any cause the removal of one of the lesser toes becomes necessary, that the operation should be performed at the metatarso-phalangeal articulation, as by adopting a different course the stump would in all probability prove an evil rather than an advantage to the foot.

If from any circumstance an amputation is deemed desirable in the continuity of the phalanges, it can be done in the same manner as in that of the fingers, viz., by a short oval flap from the dorsal surface and a long one from the plantar aspect of the toe. The same rule applies to amputation at the phalangeal articulation of the great toe as to similar operations upon the thumb.

Metatarso-phalangeal amputation of the toes.—The great size of the anterior extremity of the metatarsal bone of the great toe requires, in amputation at the metatarso-phalangeal joint, that the lateral incisions should be carried well forward, the outer one to the extreme margin of the interdigital web, and the inner one far enough to be of the same length. (Fig. 1195.) This is necessary to insure an abundant covering for the stump, as no retrenchment in the articular end of the metatarsal piece—as is sometimes practiced in the hand—is allowable. The bone must be preserved as complete as possible, so as to amplify the base of support for the foot.

When any one of the lesser toes is to be removed at the metatarso-phalangeal joint, the steps of the operation are the same as in metacarpo-phalangeal amputations. (Fig. 1195.)

Amputation of all the toes is sometimes demanded on account of frost-bite, or from their being crushed by some heavy weight.

In such a case, the extremities being held between the ball of the thumb and the fingers, the surgeon makes an incision across the phalangeal portion of the foot, from its outer to its inner border, and exactly on a line of the interdigital webs of the toes. (See Fig. 1199.)

FIG. 1195.



Lines of incision for amputation at the metatarso-phalangeal joints.

with the free edge

This flap is dissected back as far as the articulations, each one of which is to be opened on its dorsal surface. After the entire series have been severed, and the toes have been well flexed, the knife is carried through the articulations to the plantar aspect of the foot, and made to shave a flap from the under surface of the phalanges, as far anteriorly as the web of the toes extends.

Four or five metatarsal branches of the plantar arch will require ligatures, after which the two flaps may be brought together and stitched. The appearance of the foot after healing has been completed is represented in Fig. 1196.

In cases in which the operation cannot be done in the contiguity of the parts, the flaps should be dissected back, and the metatarsal bones divided in their continuity by the cutting pliers, as it is important to preserve as much of the foot as possible.

Metatarsal Amputations may be limited to a single bone, or the entire row of the metatarsus may be removed. All amputations which are practiced on the foot above the metatarso-phalangeal joints are easy of execution, provided the operator is thoroughly conversant with the topographical features of the foot. Without such knowledge he will be foiled at every step.

A brief résumé of the principal features of the foot will, therefore, not be out of place before proceeding to consider particular amputations. In looking at the skeleton of the foot (Fig. 1197), it will be seen that the three inner metatarsal bones posteriorly rest against and are articulated with (when enumerated from within outward) the internal, middle, and external cuneiform bones; and the two outer metatarsal pieces with the cuboid bone.

The internal cuneiform, unlike the others, is placed in the series with its apex upward, which answers exactly to the instep or to the highest point on the dorsum of the foot, thus furnishing the key to the joint between the metatarsal bone of the great toe and the internal cuneiform. The middle cuneiform, smaller than its associates, is not placed on a line anteriorly with the internal and external pieces, but stands some distance back, forming with the other two a mortise, into which is fitted the second metatarsal bone, which, in consequence of this arrangement, is embraced by the internal and external cuneiforms, one on either side. Upon the outer border of the foot, the metatarsal bone of the little toe terminates in a process or tuberosity: this latter extends a short distance behind the surface of articulation with the cuboid; and, as the prominence can be readily felt through the soft parts, it supplies the key to the tarso-metatarsal articulation on the outer side of the foot.

The medio-tarsal articulations, or those between the astragalus and scaphoid on the inner side and the calcaneum and the cuboid bones on the outer side of the foot, may be recognized by noticing that the head of the scaphoid is situated one inch in front of the internal malleolus, and can be felt as a distinct prominence, immediately above which is the joint; while on the external side of the foot, the articulation between the os calcis and the cuboid bones will be seen to lie midway between the peroneal tubercle on the outer surface of the calcaneum, or the tip of the external malleolus, and the tuberosity of the metatarsal bone of the little toe.

FIG. 1196.



A stump after amputation of all the toes at the metatarso-phalangeal joints.

FIG. 1197.



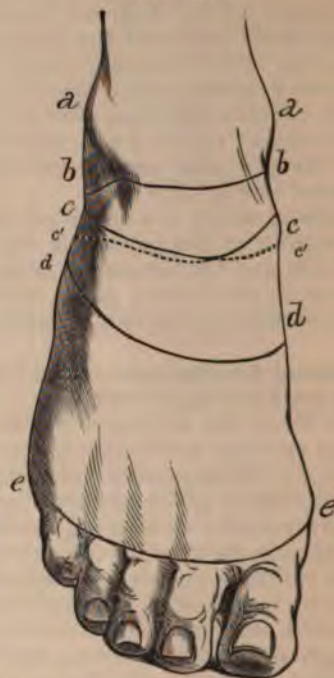
Bones of the foot and their relation to one another: 1, bones of the astragalus; 2, its head; 3, calcaneum; 4, scaphoid bone; 5, 6, 7, internal, middle, and external cuneiform bones; 8, cuboid bone; 9, metatarsal bone; 10, 11, phalanges of the great toe; 12, 13, 14, phalanges of the other toes.

The articulation between the scaphoid and the cuneiform bones is indicated by the anterior surface of the tubercle of the scaphoid. By comparing the

FIG. 1198.



FIG. 1199.



aa, malleoli; *bb*, ankle-joint, and line of incision for Syme's and Pirogoff's operations; *cc*, medio-tarsal joint, and line of incision for Chopart's amputation; *c'c'*, scaphoid-cuneiform joint, and line of incision for author's amputation; *dd*, tarso-metatarsal joint, and line of incision for Lisfranc's amputation; *ee*, metatarso-phalangeal articulation, and line of incision for amputation through these articulations.

two figures (1198, 1199) placed side by side, the articulation and the surface-markings indicating the joints, with the lines of incision for the different amputations, can be readily understood.

As many of these amputations in the foot are done in the contiguity of the parts, it is necessary not only to be able to identify the individual articulations, but likewise to know in what manner to place the foot and how to use the knife in effecting their disjunction. The heel should be placed on the lower edge of the table, so that it may be used as a fulcrum, while the foot is grasped at the metatarso-phalangeal joint in one hand of the operator, who uses it as a lever; by this means he is enabled not only to make tense the ligaments of the articulations, thus favoring their division by the knife, but also to force asunder the joints and open the way for the deeper incisions.

In severing these joints, the knife should be applied in a perpendicular position, and its point alone should be used, which should never be out of the sight of the surgeon. If more of the blade than its extremity is used, it is certain to become locked in the articulation.

So important is every portion of the foot in the human economy, both for progression and support, that it should never be the subject of a wanton sacrifice of structure. Not a line more should be taken from this member than is absolutely necessary for the cure of the injury or disease for which the operation is required. I fear that the brilliant display which is connected with the execution of a number of these conservative operations through the articulations of the foot sometimes tempts the surgeon to exceed the

limits of necessity. The laws which should govern all operative procedures on this part may be formulated thus:

(1) To remove no portion, either of bone or of soft parts, unless absolutely required to do so by the circumstances of the case. Under this rule, individual bones, or even portions of such, may be extracted with success.

(2) Even though the disease or injury may necessitate a near approach to a joint in the metatarsal and tarsal portions of the foot, it is better to saw through a bone or bones in their continuity than to enter a joint.

(3) In constructing flaps, care should be observed to secure from the sole of the foot the one which is to endure pressure.

In all these amputations through the foot, a *short* rounded flap is formed from the *dorsal* surface, and a *long* rounded one from the *plantar* surface.

The hemorrhage is controlled by placing compresses over the anterior and posterior tibial arteries above the ankle, and over them a tourniquet.

Several of the amputations practiced in the foot are great triumphs of conservative skill, and bear the names of the surgeons who have been influential in introducing them: thus, we have the operations of Lisfranc, Hey, Chopart, Pirogoff, Hancock, and Syme.

Tarso-Metatarsal Amputation (Lisfranc's).—The tourniquet being applied as directed, above the ankle, and the patient's heel being brought to the foot of the table, the surgeon grasps the foot (if the *right* one) in such a way that the thumb shall rest on the apex of the internal cuneiform bone or the summit of the instep, and the index finger on the tuberosity of the metatarsal bone of the little toe. He thus designates the two extremes of the tarso-metatarsal articulation. The position of the thumb and finger is reversed when operating on the *left* side. Between these two points a short flap is cut convex downward. The integument and tendons are next dissected back from the bones, when the knife is entered immediately behind the tuberosity of the metatarsal bone of the little toe, opening the joint between the first two bones,—the metatarsal and the cuboid bone. If the cut is made much behind this point, the tendon of the peroneus longus is liable to be severed.

The point of the instrument is next applied to the ligaments uniting the external cuneiform and the third metatarsal bone. These being divided, the articulation between the middle cuneiform and the second metatarsal bone will have been reached, and, this being placed a short distance above the others, it becomes necessary to change the direction of the knife, first upward or in a longitudinal direction, second transversely, and third downward, thus following the boundaries of the mortise which receives the body of the metatarsal bone. (Fig. 1200.) It then only remains by a transverse cut to open the articulation between the metatarsal bone of the great toe and the internal cuneiform bone. In doing this the knife must not be allowed to pass above the joint, or the tendon of the tibialis anticus may be severed.

While these incisions are being made, the toes must be forcibly depressed, so as to cause the joints to open (Fig. 1201), and thus enable the operator to complete the disarticulation by entering the point of the knife within the articulations and cutting the strong interosseous ligaments which still hold the bones together.

As soon as the disjunction is accomplished, the long plantar flap must be formed. This is done by passing the knife lengthwise through the joints to the plantar surface of the foot, and, after turning the blade flatwise, shaving all the tissues

FIG. 1200.



Separating the second metatarsal bone from its mortise between the internal and external cuneiform bones.

from the bones from within outward and from above downward. (Fig. 1201.)

In order to ascertain the exact amount of flap necessary to cover the stump, it will be well, before cutting out to the surface, to remove the knife and to turn the detached part of the foot in front of the tarsus, for the purpose of measuring; and if a sufficient extent of tissue has been separated, then to complete the incision. (Fig. 1202.) This is the operation of Lisfranc.

Mr. Hey, of Leeds, who first planned the tarso-metatarsal amputation, instead of disarticulating the second metatarsal bone from its mortise sawed it off on a level with the internal and external cuneiform bones. (See dotted line in Fig. 1198.) Numerous branches of the plantar arteries will require

FIG. 1201.



Cutting flap in a tarso-metatarsal or Lisfranc's amputation.

FIG. 1202.



Flap and front of tarsal bones after a Lisfranc amputation.

ligation, after which the long plantar flap is to be brought up and attached by interrupted sutures to the short convex dorsal flap. The stump resulting from this operation is represented in Fig. 1203.

FIG. 1203.



Stump of the tarso-metatarsal amputation.

AMPUTATION IN FRONT OF THE SCAPHOID BONE.—Cases will occur in which a Lisfranc operation, on account of the extent of injury, is not possible, and yet, if a Chopart's operation be performed, more of the foot will be removed than is necessary. Under these circumstances the articulation between the scaphoid and the three cuneiform bones should be selected for the amputation.

OPERATION.—The foot being placed in the same position as in the tarso-metatarsal amputation, an incision, convex downward, should be made across the dorsum of the foot, beginning at the tuberosity of the scaphoid bone and terminating half an inch behind the tuberosity of the metatarsal bone of the little toe. The integument being now dissected up for a short distance and reflected, the point of the knife is made to glide round the front of the scaphoid bone and enter the articulation between the latter and the internal, middle, and external cuneiform bones; the disarticulation is favored by forcibly depressing at the

same time the front of the foot. This accomplished, the cuboid bone is next sawed through with a metacarpal saw, when the knife can be passed through to the under surface of the foot and the plantar flap formed as in the operation of Lisfranc. (See dotted line in Figs. 1198 and 1199.) This operation will give a full half-inch longer stump than that obtained by Chopart's method.

Medio-Tarsal Amputation.—In case of injury or disease involving the foot to an extent incompatible with a tarso-metatarsal exarticulation, the surgeon may operate through the medio-tarsal joint, composed of the astragalus and the calcaneum above and the scaphoid and cuboid bones below. This operation is commonly known as Chopart's, though popularized by Syme. Select a point midway between the peroneal tubercle, or the external malleolus, and the tuberosity of the fifth metatarsal bone (on the outer border of the foot); find the tuberosity of the scaphoid bone, a prominence about one inch in front of the internal malleolus (on the inner side); designate these two points by placing the thumb on one and the index finger on the other as the hand grasps the foot. A curved incision should then be made down to the bones between these two landmarks, with its convexity directed downward. The flap being dissected back a short distance, the knife is made to enter the joint between the head of the astragalus and the scaphoid, and, after separating these bones, is carried across to the outer articulation, to effect the disjunction between the calcaneum and the cuboid. This done, a long plantar flap is formed by passing the knife through the joints (Fig. 1204) and shaving all the soft parts from the bones as far forward as the fleshy cushion forming the ball of the toes. As the vertical depth of the foot is greatest on the inner side, the corresponding portion of the plantar flap requires to be the longest.

Syme preferred cutting the long plantar flap by transfixion before disarticulating the bones,—an operation which is inferior to the method already described.

The arteries which demand ligation are the dorsalis pedis, the internal and external plantar, and perhaps two or three muscular branches.

The only error likely to be committed in the execution of Chopart's amputation, and which I have seen occur, is that of getting in front of the scaphoid bone instead of behind it. This need not happen if the surgeon will observe the articulating surfaces exposed. That of the astragalus is single and rounded, while the scaphoid anteriorly presents three distinct articulating facets for the three cuneiform bones.

The stump resulting from a Chopart's amputation is represented in Fig. 1205.

An objection of some force is urged against Chopart's operation, in that the anterior tendinous attachments being necessarily cut away, the gastrocnemius and soleus muscles tend to draw the heel upward, in consequence of which the cicatrix becomes exposed to pressure in walking, and hence is liable to undergo ulceration. This, however, is not an insuperable evil. The division of the tendo Achillis and the subsequent flexion of the stump until the gap is filled up will correct

FIG. 1204.



Forming the flaps in Chopart's amputation.

FIG. 1205.



Stump after the medio-tarsal amputation.

the vicious position. The necessity for tenotomy after this amputation may be obviated by maintaining the leg in a flexed position, so as to relax the muscles of the calf, until the stump has healed. The same end may be attained by moulding to the back of the leg and the heel a neatly-fitting felt splint.

Subastragaloid Amputation.—This operation, first performed by M. De Lignerolles, and afterwards by Textor, according to Velpeau, consists in removing all the bones of the foot except the astragalus. Mr. Hancock, in 1864, introduced a modification of the operation, which possesses certain advantages over the original, inasmuch as the posterior part of the calcaneum is left, and is applied against the under surface of the astragalus, from which a thin slice of bone has been sawed. This amputation must necessarily be followed by less shortening of the limb, and by a more effective power over the ankle-joint. It may become necessary in certain diseased conditions of the tarsal bones.

It is performed in the following manner. An incision is commenced below the external malleolus, cutting down upon the bone, and carried forward along the outer border of the foot to a point a little in advance of the tuberosity of the metatarsal bone of the little toe. A second incision is made along the inner border of the foot, beginning below the internal malleolus, and ending at the base of the metatarsal bone of the great toe. A third cut is made, curved with its convex face downward, across the sole of the foot, uniting the anterior extremities of the two longitudinal cuts. The plantar flap is now dissected back as far as the tuberosities of the calcaneum, keeping close to the bones. A fourth incision is next made across the dorsum of the foot, immediately behind the head of the astragalus. A saw is now to be applied to the under surface of the calcaneum, in front of the tuberosities, and the bone cut from below upward and backward. This effected, the astragalo-scapoid joint is laid open, and the knife carried in between the astragalus and the calcaneum, dividing the interosseous ligaments, separating the anterior portion of the os calcis from the astragalus, and detaching the front of the foot from its posterior connections.

It now only remains to saw off the head of the astragalus, to secure the plantar arteries, and to bring together the flaps with sutures, when the operation is completed. The difference between the subastragaloid operation and the modification of Hancock consists chiefly in the removal, in the former method, of the entire os calcis.

This amputation has rarely been performed.

Amputation at the Ankle-Joint.—Originally this amputation was performed by taking flaps from the sides, from the entire circumference of the foot, and occasionally a single one from its dorsum. The skin from these regions being entirely unsuited to endure pressure, the operation passed into disuse, until revived in 1843 by Syme and by Roux, the former demonstrating the possibility of employing the hard tissue of the sole of the foot for a flap, and the latter accomplishing a similar object by using an extensive covering of integument taken from the inner and lateral portions of the foot.

SYME'S AMPUTATION is executed as follows. The foot being placed at a right angle to the leg, an incision down to the bone is carried in a forward direction across the sole of the foot from the anterior border of the top of one malleolus to that of the other. A second cut is carried across the front of the ankle on a curved line with its convexity directed forward, and joining the extremities of the first incision at an angle of forty-five degrees. The dense tissue of the heel covering the calcaneum is now to be carefully dissected off from the bone, the thumb being interposed between the soft parts and the knife, while the latter is kept closely applied to the irregularities of the osseous surface, that the flap may not be button-holed. (Fig. 1206.) While it is important that the integrity of the fleshy cushion shall be preserved, so as

to avoid sloughing, it is possible that an error may be committed by going to the other extreme and raising with the flap portions of the periosteum from the calcaneum, in which nodules of bone may subsequently appear and keep up a troublesome irritation. Roux witnessed two instances of this kind, which would militate against the method of Macleod and Bell, who propose in this amputation to preserve all the periosteum of the calcaneum.

As soon as the plantar surface of the os calcis has been cleared, the joint must be opened in front by cutting through the anterior tibio-tarsal ligament. Afterwards, the lateral ligaments are to be severed with the point of the knife, passed between the astragalus and the malleoli. In dividing the inner ligament, the operator should be careful not to injure the posterior tibial vessel, which lies immediately behind the internal malleolus. It is always wise to avoid inflicting unnecessary damage on this blood-vessel, as an accident of this kind might seriously compromise the vitality of the flap. Mr. Erichsen and Mr. Lister allege that the integrity of the posterior tibial is not material to the life of the heel-flap. A careful dissection, however, of a well-injected foot will show that branches from the external plantar artery are largely distributed to the tissues of the heel,—a fact which has received particular notice from Dr. Wyeth, of New York. The interosseous artery frequently terminates in the same part of the foot. Sometimes a considerable branch is supplied to it from the posterior tibial immediately above its division into plantar vessels. It is in view of this arterial distribution that I prefer to carry the incision across the plantar surface of the foot from the anterior border of the tip of one malleolus to that of the other, as the parts will be divided in front of the nutrient vessels. (See Fig. 1209.)

The last step in the operation consists in detaching the tendo Achillis from the calcaneum, clearing away the soft parts from the malleoli, and sawing off the latter, including a slice of the cartilage covering the tarsal end of the tibia. The heel-tissue, being brought forward over the end of the bone, is now attached to the anterior flap.

The success of this operation depends in no small measure on the accuracy with which the posterior flap is made to rest against the end of the tibia and the fibula. Its cup-shaped form results from the shape of the os calcis, from which it is dissected; and, if cut too large and not sufficiently flattened out by pressure when applied to the bones of the leg, it is liable to form a sac or pouch for the collection of purulent formations. When such accumulations occur, an aperture may be made through the flap and a small drainage-tube introduced.

The stump after a Syme amputation (Fig. 1207) is well adapted for support, and the shortening of the limb rarely exceeds one and three-quarter inches.

Sédillot, Mackenzie, and Pirogoff have each made a modification of this operation,—the two former by taking the principal flap from the inner and plantar surface of the foot and the ankle; and in cases where the soft parts on the outer side of the foot have been destroyed, their operations will prove quite satisfactory.

FIG. 1206.



Dissecting out the os calcis in a Syme amputation.

FIG. 1207.



Stump after Syme's amputation.

In a total of 266 cases of Syme's amputation, which includes 219 analyzed by Hancock and 47 reported during the American civil war, only 26 proved fatal. Of the operations recorded by Hancock, 187 were done for disease, with 11 deaths,—a mortality of 5.9 per cent.; and 32 for accident, with 6 deaths,—a mortality of 19 per cent.

Pirogoff's Amputation.—Pirogoff, of St. Petersburg, in 1852, modified Syme's operation by utilizing the posterior portion of the calcaneum and applying it to the under surface of the tibia and fibula. By this plan a more solid base of support is obtained, as well as less shortening of the limb.

The operation is executed in the following manner. An incision is made across the front of the ankle, extending from the anterior border of the tip of one malleolus to that of the other, slightly convex forward, and about three-quarters of an inch in front of and below the ankle-joint. A second incision is carried across the sole of the foot and down to the bone, uniting

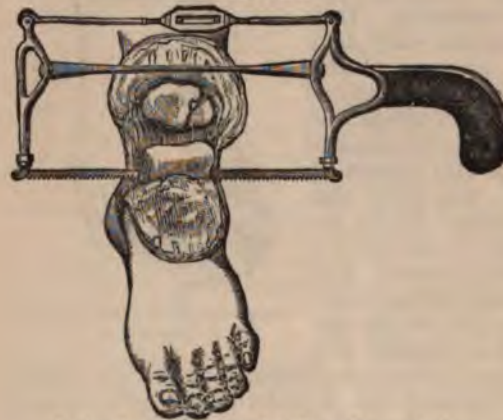
the extremities of the former. The plantar flap is now dissected up from the bone for a short distance, not exceeding three-eighths of an inch; after which the anterior or dorsal flap is to be raised, exposing the front of the joint and the malleoli. The articulation is next to be opened by cutting the anterior and lateral ligaments, when the astragalus can be carried forward from between the malleoli by depressing the foot. A narrow-bladed or a butcher's saw is now applied to the calcaneum immediately behind the posterior lip of the astragalus, and the bone sawed obliquely through in a direction downward and forward. (Fig. 1208.) The operation is completed by dissecting the soft parts back from the malleoli and sawing them off with the cartilaginous incrustation on the articular surface of the tibia, as in Syme's operation.

The relation of the incision through the soft parts to the bones, and the direction in which the os calcis and the bones of the leg are sawed, are represented in Fig. 1209.

In the adjustment of the parts, the denuded surface of the os calcis is brought up and applied against that of the tibia. If the section of the calcaneum has been sufficiently oblique, the bony surfaces will come neatly together without causing any unusual tension of the tendo Achillis; but if not,

it is necessary either to remove another slice from the bones of the leg, or to divide the tendon subcutaneously. I prefer the latter procedure.

FIG. 1208.



Sawing the os calcis through in Pirogoff's amputation.

FIG. 1209.



Lines of incision, and the direction in which the calcaneum and the bones of the leg are sawed. Relation of the branches of the external plantar artery to the heel: *a*, line of section of os calcis; *b*, lines for dividing the soft parts; *c*, line for sawing the tibia and fibula; *d*, arterial distribution.

In performing this operation, instead of sawing off the malleoli and the articular surface of the tibia, I often place the calcaneum in the mortise, between the two, with good results. (Fig. 1210.)

It is not always, however, that such a disposition of the remains of the os calcis is possible. There is a remarkable absence of anatomical uniformity in the size of the os calcis as compared with the intermalleolar space. Frequently the former is too wide to enter the latter. When this is not the case, the above plan should be adopted in preference to the original one, as the calcaneum is less liable to be displaced. The union of the bones will be somewhat hastened by paring away the incrusting cartilage from the inner surfaces of the malleoli and from the articular face of the tibia.

Pirogoff's operation is usually very successful, both as regards the subsequent usefulness of the limb and the small risk to life. Of 147 cases of this amputation collected by Hancock, Gross, and Pasquier, only 14 proved fatal (a death-rate of 9.52); 101 were known to have recovered with excellent limbs, and 5 required subsequent amputation of the leg.

The modifications of the Pirogoff operation possess no merits over the plan already described. Sédillot advised that the tibia and fibula should be divided upward and backward. Pasquier directs that both the bones of the leg and the calcaneum be sawed horizontally. Pirrie, in cutting the os calcis, sawed from below upward; the same surgeon cut off the lower extremities of the tibia and fibula, antecedent to disarticulation. Bontecou, in forming the plantar flap, cut from within outward. The appearance of the stump after Pirogoff's amputation is shown in Fig. 1211.

In summing up the relative merits of the different operations practiced on the foot, it may be said that their value diminishes in proportion to the amount of bone removed, though the least favorable of them all is superior to an amputation above the ankle.

It is thought by some that in cases of disease these amputations are scarcely admissible, as structural changes of the tarsal bones are more likely to be general than local, and that it is consequently better to amputate above the ankle. This opinion is not in accordance with my experience.

The metatarso-phalangeal amputation detracts very little from the usefulness of the foot. That of Lisfranc or Hey, though diminishing the base of support, is followed by no very serious physical disability. The objection to Chopart's operation—that of the elevation of the heel by the shortening of the muscles of the calf of the leg—is easily removed, as has been shown, by a subcutaneous division of the tendo Achillis. Pirogoff's amputation is open to the same objection as that urged against Chopart's, namely, the elevation of the heel; but this difficulty is obviated by keeping the leg well flexed until union between the osseous surfaces has taken place.

Miekulicz's Excision of the Foot consists in carrying an incision across the sole of the foot, beginning in front of the scaphoid tubercle and ending behind the tuberosity of the fifth metatarsal bone. From the extremities of this cut, two incisions are carried upward and backward across the malleoli,

FIG. 1210.



Calcaneum placed between the malleoli and solidly united to the bones. (Taken from a specimen in the author's collection, affording an excellent illustration of the result of such an operation.)

FIG. 1211.



Stump after Pirogoff's amputation.

and these two, united by a third, across the back of the leg, and all down to the bone. The ankle-joint is now opened, and the tarsal bones, with the soft part covering, are dissected away and removed up to the medio-tarsal joint. The bones of the leg are now sawed off on a level with the articular surface, and the cuboid and scaphoid treated in like manner. The latter are next sutured to the former by strong catgut, and the soft parts united in the same way. After being dressed, the stump is supported in a plaster dressing. Drs. Hopkins and F. Gross each report a case, the first two done in this city. The first operation of the kind in England was done by Sir William MacCormac. Hopkins gives 22 cases, with 17 recoveries and 5 failures.

Amputation of the Leg.

Amputations through the different parts of the lower extremity are performed by tegumentary and by musculo-tegumentary flaps, both symmetrical and asymmetrical. Lines indicating the general plan of these amputations are shown in Fig. 1212.

FIG. 1212.



Lines of incision in the different amputations of the leg and thigh.

When it becomes necessary to sacrifice the foot, and the surgeon may elect any point of the lower part of the leg for an amputation, it is desirable that the operation be done about five or six inches above the ankle, or just where the leg begins to swell into the calf, the most favorable point in view of fitting and wearing an artificial limb.

OPERATION.—The surgeon, standing on the outside of the extremity (if it be the right leg), makes an oval incision, convex downward, across the anterior part of the limb, commencing at the inner angle of the tibia, half an inch below the point where it is contemplated to saw off the bone, and terminating at an opposite point on the outer border of the fibula. This incision should include a flap at least two and a half inches in length, and should be carried down to the deep fascia. The flap being raised and reflected, a similar flap of equal extent is to be formed on the posterior part of the leg, and turned back. Both flaps are next to be loosened up for half an inch at the angles formed by the junction of the two incisions. The integument being now re-

FIG. 1213.



Amputation at the lower third of the leg by the antero-posterior oval tegumentary flap method.

tracted, the muscles are to be divided at the base of the flaps by circular sweeps of the knife; after which the interosseous structures are to be severed, by pushing the catling between the bones and carrying it repeatedly around each until all the adhering tissues are divided. The bones are then to be sawed off on a level with the division of the muscles. (Fig. 1213.) The vessels requiring ligation are the anterior and posterior tibials, the peroneal, and two or three small muscular arteries.

The rectangular or Teale operation is sometimes performed in this part of the leg, but it has no advantages over the oval flap method. The long

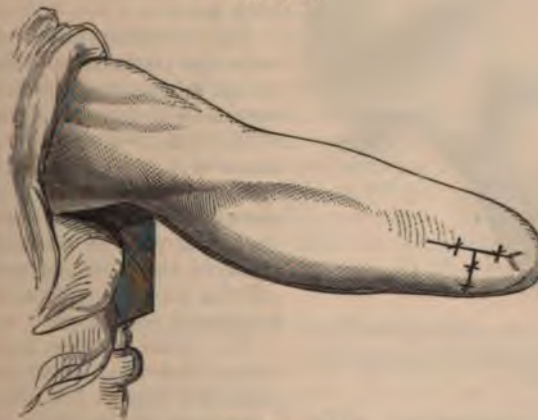
FIG. 1214.



Lines of incision in Teale's amputation at the lower third of the leg.

flap is taken from the anterior portion of the limb, and the short one from

FIG. 1215.



Flaps adjusted.

the posterior, which will include the posterior tibial artery. (Figs. 1214, 1215.)

Amputation at the Upper Third.—The removal of the leg at its upper or middle third is most satisfactorily accomplished by forming a short convex flap of integument from its anterior surface, and a long musculo-tegumentary flap from its posterior aspect.

OPERATION.—Assuming the operation to be done on the right side, commencing at the inner angle of the tibia, the knife is carried first downward, then across the limb, and finally upward, to a point on the outer side of the fibula, opposite the point of beginning, cutting a semilunar tegumentary flap two and a half inches in length. The latter, being raised from its deep attachments and reflected, is held out of the way by the surgeon's fingers, while the knife is made to transfix the limb at the angle of the first wound, taking care to pass behind and not between the bones. A long flap

is then cut from the entire width of the calf of the leg, three, four, or more inches in length, according to the size of the limb. (Fig. 1216.) The

FIG. 1216.



Section of the leg at its upper third.

operation is concluded by retracting the flaps, dividing the interosseous structures with the catling, introducing a retractor, and sawing off the bones on a level with the retracted parts: the fibula must be severed before the tibia or at the same moment with it.

FIG. 1217.



The bones, muscles, and principal arteries of the leg at the upper third as seen after a circular amputation: *a*, anterior tibial artery; *b*, posterior tibial artery; *c*, peroneal artery.

stitched to the anterior one, which is brought down like a hood over the bones.

The after-treatment of this amputation demands more than usual attention. The posterior flap must be well supported, so that there may be no drag upon the anterior flap over the tibia, which might seriously jeopardize its vitality and cause ulceration. To prevent this, some surgeons diminish the weight of the posterior flap by slicing a portion of its thickness. A cushion of oakum (placed between the calf of the leg and the pillow on which it rests) will furnish the necessary support.

When the amputation is done high up, there is always a strong disposition in the leg to become unduly flexed, through the contraction of the hamstring muscles. This must be counteracted by keeping the limb on its posterior surface, and, if this is not sufficient, by adjusting a posterior splint to the same aspect of the leg and thigh. It is rarely necessary to resort to tenotomy in order to correct the vicious position and prevent rigidity of the knee-joint. A stump resulting from the above amputation is very well represented in Fig. 1218.

The anterior and posterior tibial, with the peroneal and interosseous arteries, and some branches of the sural vessels, will demand ligation.

The relative position of the components of the leg as they appear after a circular section at the upper third is shown in Fig. 1217. Before closing the wound it will be proper to round the front of the tibia, by sawing away an oblique slice from its spine for the protection of the anterior flap.

The hemorrhage having been arrested and the nerves retrenched, the posterior flap is brought forward and

No removal of the leg should be performed above the tubercle of the tibia. The division of the tendo patellæ destroying all power to extend the stump, and the close proximity of the joint exposing the articulation to inflamma-

FIG. 1218.



tion, together with the large exposure of the cancellated tissue of the tibia furnishing a convenient avenue for the introduction into the system of the poisonous products of decomposition, are cogent reasons for condemning such an amputation.

The artificial limb worn after amputation of the leg may be either that generally known as the "peg leg" (Fig. 1219), or the more elegant mechanism of Mr. Kolbe (Fig. 1220).

MORTALITY.—Amputation of the leg, when performed for disease, may be considered a very successful operation, the mortality depending on the part of the limb removed, and steadily increasing as the knee is approached; it is also influenced by the age of the patient, being less in children than in adults. The average death-rate is about 25 per cent.

Amputations of the leg performed on account of injury yield a higher mortality. Bryant estimates it as high as 60 per cent. Malgaigne states that in the Parisian hospitals it was 63.3 per cent. American hospitals certainly furnish no such death-rate as this, the mortality being, according to the tables on mortality after amputations, etc., 31.50 per cent.

Amputation at the Knee-Joint.

Amputation at the knee-joint involves less shock to the general system than the removal of the limb at the upper third of the leg, and, in my own experience, is followed by as quick a union. It is always to be preferred, when the condition of the articulation will permit, to any amputation through the condyles of the femur.

The earliest notice of this amputation is that by Fabricius Hildanus, in 1581, who was the first to amputate at this joint. For one hundred and eighty-three years following, no attention appears to have been given to the operation, until it was revived in 1764 by Hoin, receiving then also the commendation of Petit and Brasdor. Notwithstanding the support accorded it by these distinguished surgeons, there appears to have lingered a strong professional prejudice against the operation, as it was still doomed to over half a century of forgetfulness until revived and made popular by Velpeau in 1830. In 1824, Dr. Nathan Smith amputated at the knee-joint, and his operation was the first of the kind done in America. Indeed, the subject has received more attention in this country than abroad, and has been more popular as an amputation in the United States than with our transatlantic brethren.

OPERATION.—Amputation at the knee-joint may be executed in four differ-

FIG. 1220.

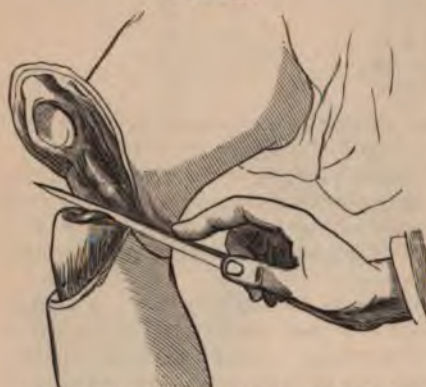


ent ways: *first*, by the *oval* method, or that of Baudens, which consists of a long anterior and short posterior flap; *second*, by a *long anterior* flap; *third*, by *triple* flaps, known as the plan of the elder Professor Pancoast; and, *fourth*, by lateral flaps.

The antero-posterior flap, or oval method, is the one which I generally employ, as, in my judgment, possessing advantages over other operations. The limb being extended and brought over the end of the table, an incision (if the left leg be the subject of amputation), commencing near the posterior border of the internal condyle and a little below the level of its tuberosity, is made directly down the inner side of the leg, to a point two or three finger-breadths below the level of the tuberosity of the tibia; it is then carried across the front of the leg in a slightly curved line to the opposite side, and from thence upward to a point on the external condyle of the femur answering to that on the internal condyle where the knife was first applied. The integument is rapidly dissected up as high as the tubercle of the tibia, when an assistant flexes the leg, thereby making tense the tendo patellæ, which is next to be divided, and after it likewise the capsular ligament, thus exposing the cavity of the articulation.

The surgeon now turns back the anterior flap containing the patella

FIG. 1221.



Anterior flap raised, containing the patella, and the knife passed through the joint preparatory to cutting posterior flap.

(Fig. 1221), and, leaving the ligamentum mucosum undisturbed, divides the lateral and crucial ligaments. In cutting the crucial ligament, care should be exercised not to wound the popliteal vessels with the point of the knife.

The disarticulation being accomplished and the leg well flexed, the knife is passed through the joint, and made to cut a musculo-tegumentary flap, three inches in length, from the posterior aspect of the limb. The semilunar cartilages should next be removed from their ligamentous connections with the tibia.

The object in directing that the extremities of the anterior incision should not extend higher than the tuberosities of the femur is to avoid severing those bands of fascial and fibrous tissue which serve to connect the involucrem of the joint, and with it the quadriceps muscle, to these portions of the bone. When this direction is disregarded and the incision is carried higher, the powerful muscles of the thigh, realizing no check, are liable to retract and strip the condyles of the femur. It is to resist this same tendency that it has been advised not to cut the ligamentum mucosum, which extends between the intercondyloid notch and the anterior flap. The necessity for beginning and terminating the anterior cut far back is that its extremities may conduce to an easy drainage.

Another question of some importance is, what disposition to make of the patella. Should it be dissected out from its bed in the anterior flap, as some advocate, or should it be allowed to remain? The excision of the bone renders the vitality of the flap precarious. My own practice has been always to allow it to remain; and I have never discovered any evil resulting from so doing. Its tendency to be drawn up on the anterior face of the thigh has been urged as an objection to its presence. But this is easily obviated by following the directions already given in reference to not carrying the incision for the anterior flap too high on the sides of the condyles. Neither is there any valid reason for removing the articular cartilage, when it is sound, from the condyles of the femur, as some have advised. It should not

be disturbed. The idea that its disintegration retards the process of healing is not sustained by experience. Nor is it desirable to remove a thin slice from the under surface of the patella, as is occasionally done. If, however, the section is made from the surface of the condyles, the patella should be similarly treated, and the two surfaces applied against each other, in order that union may be effected.

In ligating the popliteal vessels, the vein and artery, which normally are very closely united by connective tissue, must be separated, and not tied together, as otherwise, during the subsequent ulceration of the thread, the cavities of the two might communicate and give rise to an arterio-venous aneurism. The vein will often demand a ligature. I have tied it in several instances without causing any trouble.

In addition to the popliteal artery, four or five smaller branches, as the articulators and the surals, may require to be secured.

In adjusting the wound, the long anterior flap is carried, as a hood, over the condyles of the femur, and is stitched to the short posterior flap. The dressing being now applied to the stump, the thigh should be somewhat elevated, and a roller bandage carried up the limb to the groin, so as to resist the retraction of the muscles.

The long anterior flap.—In adopting this method, the anterior flap is cut in the same manner as in the previous operation, differing only in its length; it should extend nearly four inches below the tubercle of the tibia. The tissues on the back of the knee are divided directly across, joining the extremities of the anterior incision. (See Fig. 1224.) After the disarticulation the anterior flap is folded round the condyles of the femur and united by sutures to the edge of the posterior wound.

Triple flaps.—This plan is original with Professor Pancoast: the operation is performed by making a short oval flap anteriorly (the patella being included) and two latero-posterior flaps, which join in the middle of the popliteal region.

Lateral flap method.—This is the operation of Professor S. Smith, of New York. The flaps are tegumental, and are made by two incisions, which, beginning one inch below the tubercle of the tibia, diverge over the sides of the leg and join each other posterior to the articulation. The patella is also retained in this operation.

The stump which results from a successful amputation at the knee-joint has an excellent form, is well adapted to receive an artificial limb, and admits of being advanced by the quadriceps muscle, as in the ordinary movements of walking.

RESULTS.—Dr. Markoe, of New York, in a collection of 46 cases drawn from the practice of American and European surgeons, found the mortality to be 37 per cent.,* while Dr. John H. Brinton, of Philadelphia, in an aggregate of 164 cases of this amputation, ascertained the death-rate to be in chronic disease 22.58 per cent., for injury 40.62 per cent., and for both together 32.31 per cent., 111 of the patients dying and 53 recovering.† Mr. Lane analyzed 60 cases, with 21 deaths,—a mortality of 35 per cent. As far as published, the records of the Surgeon-General's Office furnish 211 cases, with 106 deaths, or a mortality of 50.2 per cent. If with these data we compare the results of amputation of the thigh done for shot injury during the late American war, it will be seen that in the latter the mortality is about 19 per cent. greater than in the former,—namely, in 1597 cases of thigh amputation there were 1029 deaths, or a mortality of 64 per cent. When amputations of the leg and of the knee are contrasted, we find the fatality of the two to be about the same,—namely, from 32 to 33 per cent.

* New York Journal of Medicine, 1856.

† American Journal of the Medical Sciences, April, 1868.

Amputation at the Thigh.

Amputations may be made in any part of the thigh. They may be arranged in three groups,—namely, amputations in the *lower extremity*, in the *shaft*, and at the *upper extremity* of the bone.

Those at the lower end of the femur may be termed *condyloid* and *supra-condyloid* amputations.

Condyloid Amputations.—Circumstances may occur to necessitate amputation and the articular end of the femur may be found to be in a diseased condition. In such an event the leg may be removed by forming two oval flaps,

FIG. 1222.



Lines of incision in a condyloid amputation.

one from the front and the other and shorter from the back of the knee, the first extending from the most prominent part of one condyle to the corresponding point on the other side, and crossing the leg two inches below the tubercle of the tibia. (Fig. 1222.) The integument is to be dissected up from over the patella, and the latter bone

is to be separated from its muscular connections above and turned down.

The articulation being now opened and its ligaments divided, the posterior flap may be cut in two ways,—either by raising a semilunar flap, consisting of integument, and making a transverse cut through the muscles and tendons on the back of the condyles of the femur, or by carrying the knife through the articulation, as in an ordinary knee-joint amputation, and shaving a musculo-tegumentary flap from the posterior aspect of the limb. Whichever plan is adopted, after its execution the condyles of the femur are to be sawed off on a level with their cartilaginous incrustation; and, after securing the vessels, the flaps are to be brought together and united by sutures, the line of approximation being near the posterior aspect of the stump.

LONG POSTERIOR FLAP.—Another form of condyloid amputation is that in which a short and slightly oval flap is first cut from the front of the knee, and a long musculo-tegumentary one from the calf of the leg.

The knife is drawn across the knee at the upper margin of the patella and from one condyle to the other, cutting through the integument, fat, fascia, and quadriceps extensor muscle, and opening the joint, after which follows the division of the lateral and crucial ligaments, when the knife is carried through the articulation and a long and broad flap cut from the calf of the leg. The articular surfaces of the condyles are next sawed off; and, after securing the vessels, the posterior flap is brought up in front of the bone and stitched to the short flap on the anterior face of the thigh. This operation supplies a very excellent stump, and one well adapted to tolerate pressure.

CARDEN'S AMPUTATION.—This amputation, which was introduced in 1846, consists in cutting a rounded tegumental flap from the front of the knee, suf-

FIG. 1223.



Carden's amputation.—From Bryant.

ficiently long to cover the end of the stump, and which requires that the incision shall extend below the tubercle of the tibia. The integument being dissected up from the patella and the knee flexed, the remaining soft parts are divided by a circular sweep of the knife down to the bone, and then retracted, after which the femur is sawed off at the base of the condyles.

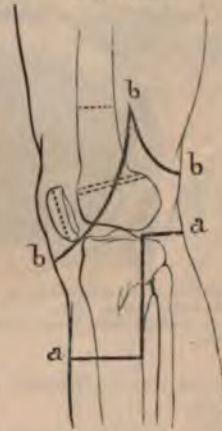
In dressing the wound, the anterior flap is turned beneath and attached by sutures to the edge of the posterior wound. (Fig. 1223).

The advantages of the condyloid method over an operation performed in

the shaft of the femur are very apparent. The medullary canal is not opened, a greater length of leverage is preserved to the limb, the danger to life is lessened by increasing the distance from the trunk, fewer vessels are divided, and, of course, less blood is lost, in addition to which the integument forming the end of the stump is well suited to endure pressure. The operation has proved eminently successful in Mr. Carden's hands, that surgeon having reported 30 amputations with only 5 deaths.

GRITTI'S OPERATION.—The operation to which this name is applied is no novelty in Philadelphia, having been done many years ago by Dr. George Fox at the Pennsylvania Hospital, and more recently, in the same institution, by Dr. Hunt. By this method an anterior tegumental flap is formed from the front of the knee, by carrying an incision from two inches above one condyle of the femur to a similar point on the other side, and crossing the leg immediately below the tubercle of the tibia. The integument is raised, the tendo patellæ divided, and the flap turned back, containing the patella, from the under surface of which a thin slice is sawed off. A short tegumental flap, slightly convex downward, is now dissected up from the back of the knee, the synovial membrane is divided in front of the joint, and the femur sawed off above its articular surface. (Fig. 1224.) The operation is completed by dividing the remaining soft parts from without inward, when, after tying the vessels, the long anterior flap, containing the patella, is brought down and the freshened surface of the latter applied to that of the condyles, somewhat as the os calcis is made to rest against the lower end of the bones of the leg in Pirogoff's amputation.

FIG. 1224.



aa, Lines of incision in forming long anterior and short posterior flaps in knee-joint amputations; *bbb*, incision in supra-condyloid amputation of the thigh by the Gritti plan. Section of the patella and femur in Gritti's condyloid amputation indicated by the dotted lines.

Supra-Condylod Amputation.—This operation is known as that of Stokes, of Dublin, and differs from Gritti's only in sawing off the femur sufficiently near to the base of the condyles not to expose the medullary canal, and bringing in contact the cancellated tissue of the latter bone and the patella.

Amputation in the Shaft of the Femur.—The thigh may be removed at any point between its articulating extremities, but it is of vital importance that not one inch more than is absolutely necessary be cut away, for the fatality of these operations rapidly increases as we ascend the limb.

The methods of thigh amputation which are employed by surgeons are, that of the musculo-tegumentary flaps, double, single, and lateral, the method of semilunar tegumentary flaps, and the Teale or rectangular method.

The musculo-tegumentary flaps possess, in my judgment, advantages over all others, and should be cut from the anterior and posterior aspects of the limb. As the skin retracts very much more than the muscles, I always employ a modification of the musculo-tegumentary plan, which I have explained under the head of preliminary or general remarks on amputations.

It is done as follows. Two semilunar flaps are raised to the extent of one inch and a half from the anterior and posterior aspects of the limb. These being reverted and held out of the way by the fingers of an assistant, the muscular and other components of the limb are divided, by pushing the knife through at the angles formed by the junction of the first incisions, and by cutting out to the surface of the limb at the line where the tegumentary flaps are reflected. In forming the muscular flaps, the anterior one should be cut first when operating below the middle of the thigh, as it does not contain the femoral blood-vessels. But, when operating above the middle,

the posterior flap should have precedence, as the vessels are situated anteriorly.

The flaps being turned back and retracted by an assistant, the amputating knife is swept around the femur on a level with the reverted tissues, in order to clear the bone, at which point the saw is applied and the limb severed.

FIG. 1225.



Relation of the components of the stump after a transverse section of the thigh: a, femoral artery; b, femoral vein; c, muscular or perforating arteries.

The vessels requiring ligation at the lower half of the thigh are the femoral, the anastomotic, and four or five muscular branches from the deep femoral. The relations of the muscles, blood-vessels, and

FIG. 1226.

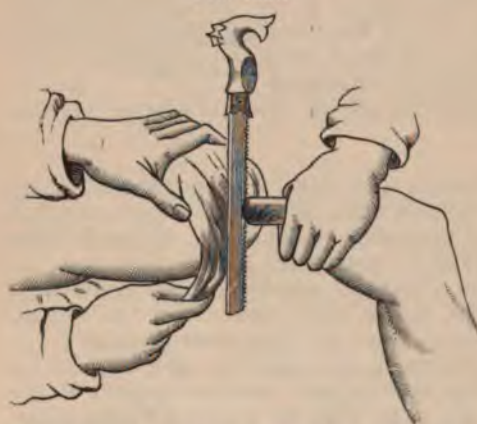


Anterior flap in thigh amputation divided by transfixion and reverted.

nerves are exhibited in Fig. 1225, taken from a transverse section of the thigh.

The musculo-tegumentary flap operation, as ordinarily performed, is more simple, but less satisfactory when the parts are being adjusted.

FIG. 1227.



Amputation of the thigh,—anterior and posterior flaps retracted preliminary to sawing off the bone.

The operator, when amputating below the middle of the thigh, pinches up between the thumb and fingers all the soft parts in front of the femur, transfixes the mass as near to the bone as possible, and cuts obliquely downward and forward a flap one-third longer than half the diameter of the limb. This flap being reflected, a similar one (Fig. 1226) is now cut from the posterior part of the thigh, by passing the knife through at the angles of the first wound, between the muscles and the bone, and cutting downward and backward. (Fig. 1227.) The posterior flap is sometimes formed by transfixion and cutting from within

outward, and the anterior one by cutting in the opposite direction, or from without inward.

Vermale's amputation of the thigh by lateral musculo-tegumentary flaps, though favorable to drainage by the vertical disposition of the wounds, is objectionable on the ground that, from the weight of the soft parts, the end of the bone is liable to become exposed at the upper angle of the wound.

The *rectangular* or *Teale* method has only a limited application in this part

of the limb, as in a majority of cases demanding amputation of the thigh it is attended with too great a sacrifice of the member.

Amputation in the Trochanteric Part of the Femur.—Amputation even through the trochanters is preferable to disarticulation at the hip-joint. It may be required on account of severe injuries involving the upper half of the thigh, or for morbid growths, such as enchondroma. The method of removing the thigh in this situation does not differ from that employed lower down. And even if, after proceeding to the amputation, the disease or injury requires the disarticulation of the limb, the latter operation is in no way interfered with.

ARTIFICIAL LIMB.—The artificial limb which is ordinarily employed after thigh amputation does not materially differ from that used for the leg. (Figs. 1228 and 1229.)

RESULTS.—The mortality attending amputation of the thigh is very considerable; but it is influenced much by the circumstances demanding the operation, by the place of removal, by the age of the patient, by the period at which the operation is done, and even by the hospital in which the case is treated.

Shot wounds.—When performed on account of shot wounds, the fatality, always very heavy, varies greatly. Among the French troops, both in the Crimea and in Italy, the mortality of thigh amputations was 90 per cent. During the late American war, so far as ascertained, it was 64 per cent. Taking together the results of English, French, and American operations, it is about 77 per cent. Dr. S. W. Gross, in a very elaborate paper* on the subject of thigh amputations for shot wounds, has formulated 4123 cases, 977 of which recovered and 3146 died,—a death-rate of 76.30 per cent. The same writer has classified 729 amputations of the thigh in a manner to exhibit the mortality as determined by the particular part of the limb removed: thus, of 236 amputations performed in the lower third of the thigh, 130 died,—a death-rate of 55.08 per cent.; of 268 in the middle third, 175 died,—a mortality of 65.26 per cent.; and of 225 in the upper third, 177 died, or 78.66 per cent.

Primary amputations, whether performed in military or in civil life, are about 25 per cent. more fatal than secondary amputations. In civil hospitals the average mortality of thigh amputations is about 52.33 per cent.

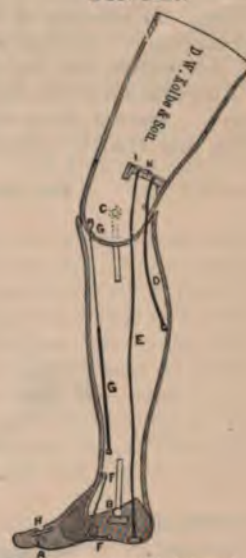
A much more favorable result is obtained when the thigh is amputated for chronic disease. In a collection of 348 cases made by Bryant, 81 died,—a mortality of 23.27 per cent.

The influence of age on the mortality is very marked. Selecting as an illustration amputation done for chronic disease of the hip- and knee-joint, it will be found that under the age of twenty years the mortality is about 2 deaths in 23 cases of amputation, while over that age it is about 33 per cent.

FIG. 1228.



FIG. 1229.



Artificial limb for the thigh, with an exposure of its internal mechanism.

* American Journal of the Medical Sciences, October, 1867.

Amputation at the Hip-Joint.

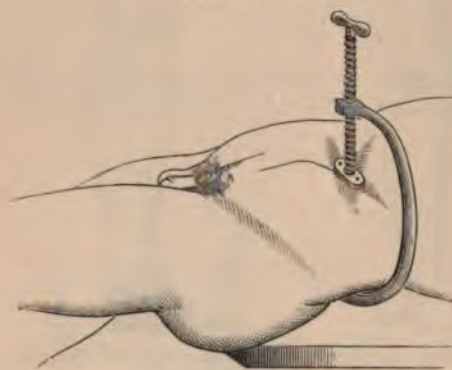
Perhaps no operation in surgery more strikingly exhibits the amazing power of enduring mutilation possessed by the human body, or better illustrates the boldness of surgery, than an amputation at the hip-joint. Under the most favorable circumstances the danger to life is so great that only when no alternative remains should the operation be undertaken.

Among the causes which may render it necessary to amputate at the hip-joint are shot fractures and other injuries involving the articulation and accompanied with extreme laceration of the soft parts immediately around; lesion of the femoral artery at the groin; osteomyelitis; and morbid growths at the upper part of the thigh.

The mortality following these amputations arises from hemorrhage, primary and secondary; from exhaustion, either from shock or prolonged suppuration; and from the complication of surgical fever. With proper precautions there need be very little loss of blood at the time of the amputation, though no amount of forethought can effectually guard against secondary hemorrhage. In this way I lost a patient fourteen days after the removal of the limb at the hip.

Amputation at the coxo-femoral articulation may be performed in several ways. Among these may be named that by circular and oval tegumentary flaps, and that by antero-posterior or by lateral musculo-tegumentary flaps.

FIG. 1230.



Abdominal tourniquet.

The methods which admit of the most rapid execution, and which are attended with the least possible loss of blood, are those by the oval tegumentary and the antero-posterior musculo-tegumentary flaps.

Whatever plan is selected, one of the first considerations is to prevent the effusion of blood. With this object in view, the Esmarch elastic bandage should be applied to the limb from the toes upward, sufficiently high not to interfere with the construction of the flaps. In this way the blood can be forced out of the vessels of the extremity into the body. As soon as the elastic cord is placed around the

limb, at the point where the bandage ceases, the latter can be removed. This done, the abdominal tourniquet of Dupuytren, as modified by Professor Pancoast (Fig. 1230), should be placed around the body, and the pad screwed down upon the aorta until all pulsation in the femoral arteries is found to have ceased.

In the application of this instrument the following directions will be found of value. The patient should be turned upon his right side, in order that the intestines may be rolled over in that direction and so escape the pressure of the instrument, which otherwise might seriously injure their walls, and also that as little of the contents of the abdomen as possible shall intervene between the aorta and the abdominal parietes. That the pressure may be concentrated on the vessel, a roller bandage should be previously fastened to the pad of the instrument. The pad, in order to act with accuracy, must be placed over the abdominal walls immediately to the left of the umbilicus.

Another method of preventing hemorrhage during this amputation is by "Davy's lever," an instrument which is designed to compress the aorta

through the rectum. In a case operated on by W. M. Armstrong at the Greenwich Hospital School, this device was adopted with entire success.

OPERATION BY OVAL OR OVAL TEGUMENTARY FLAP.—This method, though less rapidly executed than the musculo-tegumentary plan, possesses certain advantages which, in my judgment, entitle it to precedence over all others. It can be done with a very small loss of blood, and in its performance we get rid of the mass of muscular tissue which enters into the musculo-tegumentary flaps, and which, during the suppurating period, retains in its crevices a large amount of pus, which, undergoing decomposition, exposes the patient to the risk of blood-poisoning.

In executing the operation, the patient, after being etherized, and after the limb is emptied of its blood and the tourniquet applied, is brought down with the hips projecting over the lower end of the table. An assistant now takes hold of and supports the limb, while the surgeon makes a semilunar incision in front of the limb, with its convexity downward, and commencing midway between the anterior superior spinous process of the ilium and the trochanter major on the outside, descending the thigh in a longitudinal direction for five inches, then passing across the front of the limb in an oval course, adding thereby an inch to the length of the flap, and, last, ascending the inner border of the thigh, and terminating one inch below the ramus of the pubis. The integument is now rapidly dissected up from the deep fascia, and intrusted to the fingers of an assistant.

The next step is to isolate the femoral vessels above the origin of the profunda, and to apply, separately, to the artery and the vein a strong ligature. By displacing the pectineus muscle the obturator artery can be readily found and ligated below the obturator membrane.

The limb being now raised, the surgeon proceeds to cut a semilunar tegumentary flap from the back of the thigh, one inch shorter than the anterior. With an amputating knife the muscles are then severed circularly in front of the joint, when the assistant having charge of the limb carries it in a backward direction, thus causing the head of the femur to press against the front of the capsular ligament, and giving the surgeon an opportunity to divide the latter, and, after it, the teres ligament. This done, the bone immediately starts from its socket, when, the limb being rotated inward, the operator is enabled to carry the knife through the joint and behind the great trochanter, completing the operation by cutting through the muscle on the posterior aspect of the joint.

The moment the limb is severed from the body, one or two soft napkins should be thrust against the surface of the wound, particularly its posterior part, so as to prevent bleeding, and should only be removed by installments, as the vessels are exposed and tied.

After the arteries have been secured, a drainage-tube should be inserted and the flaps stitched together, when the line of approximation will be found sufficiently dependent to drain off all accumulations from the wound.

The dressings applied to the stump to absorb the discharges can be conveniently retained in place by a spica roller.

This operation, though apparently somewhat tedious, may, by a dexterous operator, be completed in forty seconds.

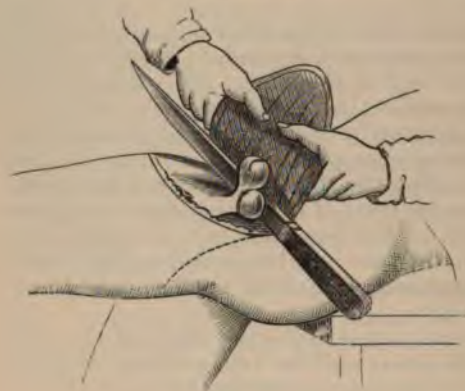
MUSCULO-CUTANEOUS FLAP METHOD.—The preliminary arrangements being made as in the operation just described, embracing the position of the patient and the application of the abdominal tourniquet, an assistant, grasping the limb, flexes the thigh somewhat on the pelvis, so that the capsule of the joint may be relaxed and made prominent. The surgeon, using a narrow-bladed knife, twelve or thirteen inches long, enters its point half-way between the trochanter major and the anterior superior spinous process of the ilium, and, pushing it across the front of the joint, shaving the capsule of the latter as it advances, brings it out on the inner side of the limb at the junction of the thigh with the scrotum, the latter being held out of the way. With a rapid sawing motion a broad flap six inches long, consisting of muscle and integu-

ment, is cut downward and outward. Before the knife is turned towards the surface in forming the flap, the latter is grasped between the thumbs and fingers of an assistant, who stands between the operator and the side of the patient, and who both compresses the vessels and retracts the divided mass.

The assistant who holds the limb now quickly carries it backward, when, the capsule being incised, the head of the bone leaves the acetabulum. The round ligament is next severed, the limb rotated inward, and the knife passed

through the joint to the posterior aspect of the limb, from which a musculo-cutaneous flap five inches long is now cut. (Fig. 1231.)

FIG. 1231.



Hip-joint amputation.

HISTORY.—Morand appears to have been the first surgeon who first seriously contemplated this formidable amputation, and doubtless it was the influence of his opinions which inspired the two essays presented in 1739 to the Royal Academy of Surgery in Paris by Volner and Puthod, both of whom had been pupils of Morand. It was not, however, until 1760 that this operation received the approbation of the learned men composing the Academy of Surgery, and that chiefly through a communica-

tion to this body by Barbet, who not only defended the operation, but specified the cases which seemed to demand its performance. Numerous other similar papers followed that of Barbet.

The first operation of the kind on the living subject is attributed to La Croix, of Orleans, in 1748. This, however, cannot be strictly regarded as an amputation in any sense, as the limb of the patient (a boy fourteen years old) had undergone an almost entire spontaneous separation, consequent on the sloughing of ergotism, leaving the ligamentum teres and the sciatic nerve to be severed. The lad died fourteen days after the operation.

The first successful case of this amputation was done nearly about the same time in France and in England,—in the former by M. Perrault, of Saint-Maur, in 1773, on account of gangrene following an injury, and in the latter, it is believed, by Mr. Thompson, of the London Hospital. Whether the case credited to the last-named surgeon be authenticated or not, there remains no doubt that, in 1774, Mr. Kerr, of Northampton, performed an amputation at the hip-joint for hip-disease in a little girl, who died from phthisis pulmonalis eighteen days after the operation. Little more was heard of this amputation until about 1794, when Blandin recorded three cases in which he removed the limb at the hip-joint for shot injuries, two of whom recovered, and the third survived the amputation two months. These cases were followed by one of Perret, another French military surgeon, one in 1796, by Mulder, and by three cases of Larrey, two of which were done during the campaign in Egypt, and the third while on the Rhine with the French army.

In December, 1812, the first successful case of this operation by an English surgeon was performed by Mr. Brownrigg, on a soldier who had suffered a severe shot fracture in the upper part of the femur while in Spain.

In America, Dr. Brashier, of Kentucky, in 1806, performed the first successful operation of this kind, and another was done with a like favorable result by Dr. Mott. In Philadelphia, amputation at the hip-joint has been performed by Dr. Duffy, Professor Gross, the two Pancoasts, Hewson, Packard, Ashhurst, Forbes, Hunter, Morton, and myself.

RESULTS.—In 122 cases of hip-joint amputation, 111 of which are from Circulars No. 7 and No. 2 issued from the Surgeon-General's Office, and 11 from other sources, 38 recovered and 84 died,—a mortality of 69 per cent. In 175 amputations for shot wounds, the death-rate amounted to 90 per cent.

The fatality of primary amputations at the hip-joint is one-third greater than that following secondary operations. There is also a great difference in the death-rate according as the amputation is performed for disease or for injury. In 45 cases of the former 21 died, while in 43 of the latter 36 proved fatal.

Re-amputation at the hip-joint yields a favorable result, 5 out of 8 cases recovering,—a death-rate of 37 per cent.

The tables of Dr. Sheppard, of Philadelphia,* embrace an analysis of 633 cases of hip-joint amputation and include—

First, 238 cases done in military practice, 96 of which were primary and 63 intermediate, with the appalling mortality, respectively, of 92.7 per cent. and 93.6 per cent. The secondary operations, 27 in number, yielded a mortality of 62.9 per cent., and the re-amputations of the thigh-stump, 7 in number, a death-rate of 42.8 per cent. Of the amputations done for causes not mentioned, 45 in number, the death-rate was 88.6 per cent.

Second, 71 cases done in civil practice gave a mortality of 66.1 per cent.

Third, 276 cases performed for disease yielded a mortality of 40.2 per cent.

Fourth, 48 cases done for causes not stated gave a mortality of 77.2 per cent.

Of the whole number of cases, 633, the death-rate was 64.1 per cent.

* International Encyclopædia of Surgery, vol. i. p. 676.

CHAPTER XXI.

SHOCK—TRAUMATIC FEVER.

Shock is a term used to express the collective phenomena which follow the infliction of some violence to the body through the nervous system. It may be defined to be a partial suspension of the functions of organic and animal life.

SYMPTOMS.—In light cases of shock there may be experienced only a slight pallidity of the surface, accompanied by a sense of muscular weakness, a little nausea, and a few drops of perspiration standing on the brow or the face. In more severe or typical cases, the first effect is seen in a depressed state of the heart. The pulse is feeble, thready, slow, becoming, after a time, more frequent, and occasionally irregular. The countenance is pale; the face shrunk; the alæ of the nose dilated; the eye dull and without lustre, the lids half closed; the skin shrunk, cold, and clammy, or wet with perspiration; the breathing quiet, scarcely perceptible, and now and then interrupted by sighs. There is great muscular prostration, the patient lying supinely in one position, generally on the back. There may be also paralysis of the sphincters of the bladder and rectum. Sometimes there is mental stupor or bewilderment, though often the mind is perfectly clear and rational. The special senses participate in the general disturbance. The vision and the hearing are less acute than naturally, and the same is true of olfaction, gustation, and general sensibility. In addition to the above symptoms, there are others less commonly noticed, as tremor, muscular twitchings, intolerance of light, vertigo, and vomiting.

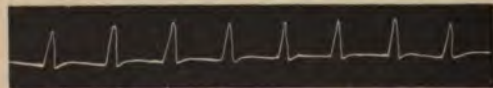
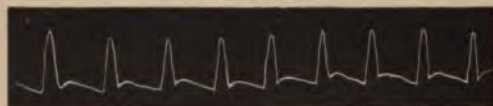
The temperature in shock is ordinarily very little below the normal degree.

In slight cases the symptoms of shock may pass over in a few minutes; but in those of greater severity they may continue for hours, and even for one or two days. In some instances there exists an exciting struggle between reaction and depression; the system makes a gallant attempt to recover from the influence of the violence; the symptoms in some measure abate, but the recuperative effort is not sustained, the tide of battle turns, and the forces of the enemy again become dominant. And so the conflict is waged, now the

one and then the other yielding or advancing, until the struggle closes either by recovery or by fatal collapse.

A number of sphygmographic tracings, taken at my request, at the Pennsylvania Hospital, by Dr. Mellvaine, in cases of shock, exhibit in a very marked degree the loss of arterial tension indicative of great cardiac feebleness. Fig. 1232 is a pulse-tracing taken from a patient

FIG. 1232.



Pulse-tracing in a case of shock.

who, in consequence of being run over by a heavy truck, had his thigh and pelvis fractured, and who died on the evening of the fourth day succeeding the accident. The pulse would frequently change in a period of fifteen minutes from seventy-five to one hundred and twenty beats. The temperature at no time exceeded 99° , and just before death it fell to 96° .

When reaction takes place, it is announced by a gradual amelioration of the symptoms. The power of the heart begins to increase, and, as a consequence, the strength, fullness, and regularity of the pulse. The blood comes out of its lurking-places in the deep organs of the body, and finds its way to the surface in more generous streams; the color begins to return to the face and the lips; the warmth of the trunk, and still later that of the extremities, is felt again; the clammy moisture bedewing the surface dries away; the respiration becomes fuller and freer, and the operations of the mind resume their orderly action. As in concussion of the brain, one of the earliest signs of reaction after shock may be the occurrence of vomiting.

When, on the other hand, a fatal termination is to follow, death may be sudden, produced by heart-spasm, the ventricles forcibly contracting and then ceasing to beat. Generally, however, the fatal approach is more gradual. The innervation of the heart becomes more and more imperfect, and, consequently, its power is lessened, so that the pulse is undistinguishable at the wrist. The temperature continues to fall; the power of utterance or motion is entirely lost; and the patient sinks into a state of unconsciousness ending in death.

Traumatic delirium.—Reaction from shock may occur in another manner. After one or several attempts on the part of the system to recover from the depression, reaction is finally established; but, as in the swing of the pendulum, the opposite extreme is reached. The skin becomes dry and hot, the pulse is full and throbbing, but soft and compressible, the face is flushed, the conjunctiva is injected, the respiration is short, hurried, and broken by feeble sighs, the tongue dry and tremulous, the thirst urgent, and, in addition, there are continued nausea and vomiting. The stupor and apathy of shock are exchanged for restlessness, jactitation, and subsultus of the tendons. The sleep is fitful, broken, and uneasy. The orderly operations of the mind are disturbed,—a result sometimes expressed in a quiet delirium or incoherent muttering, at other times in great irritability or in singular caprice, and often in maniacal raving.

The excitation of the nerves and of the circulatory system may gradually subside and recovery follow. Should, however, the disease tend to a fatal issue, the former symptoms are followed by extreme exhaustion; a cold, clammy sweat breaks out, the pallor returns to the face and lips, the countenance assumes a careworn, haggard expression, the eyelids are nearly closed, the pulse becomes feeble, rapid, and tremulous, and the scene is closed by convulsions ending in profound coma and death.

In such a picture there may be an illustration of that wonderful provision which resides in the organization to meet extraordinary emergencies, and which, though conservative, is nevertheless often destructive. The heart, deprived of the nerve-power necessary to fulfill its task of supplying sufficient blood to the organs and tissues of the body, attempts to supplement the deficiency by increasing the number of its beats. This increase of function with a lessened source of power must necessarily be followed by exhaustion and the reappearance of symptoms of prostration, the danger of the patient being greatly enhanced.

The above symptoms answer to that condition which Mr. Travers* has described as sometimes following shock, and which he designated "prostration with excitement," in which the energies of the system are diminished by excessive reaction.

Nervous delirium.—In some instances, during the reaction from shock a group of symptoms develops resembling those which belong to delirium tremens, sometimes called nervous traumatic delirium. When occurring in a person of intemperate habits, it may be considered as an attack of mania a potu. The dominant features of this state are a feeble, rapid pulse, a moist skin, a heavily-loaded tongue, which is very tremulous when protruded from the mouth, and either a blustering or a muttering delirium, in which the

* Travers on Constitutional Irritation, p. 475.

mind is annoyed with some single hallucination, but which can be dissipated for a time when the patient's attention is drawn to some other subject. In persons whose health has been damaged by intemperance and other forms of debauchery such a condition forebodes great danger. It is usually ushered in by insomnia and restlessness.

The reaction which follows shock, especially in females, may take a hysterical turn, the patient screaming, crying, singing, or laughing, according to the mental mood.

Secondary shock.—A patient may rally from the effects of an operation, and, after a few hours, may relapse into a state of alarming exhaustion. The symptoms attending this condition are a lowering of temperature, a feeble pulse, a pinched expression with pallor of the face, occasional vomiting, an unusually rapid respiration, and often a state of mental indifference. The whole group of symptoms indicate an insufficiency of heart-power. The motor resources of the cardiac ganglia appear to have been expended in establishing reaction after the operation, and, consequently, are unable to supply the necessary power to continue or to sustain the heart's action. A frequent cause of death, as a result of the feeble circulation, is the formation of a heart-clot, which, by preventing the contraction of that organ, finally arrests its action altogether. This coagulum may also disintegrate into fragments, or emboli, as they are termed, which, borne away upon the blood-stream, become impacted in the small pulmonary and cerebral arteries, forming serious obstructions to the circulation in these vessels.

This secondary shock is not uncommon after prolonged surgical operations and after severe railroad and other injuries in which there has been extensive contusion or laceration accompanied with considerable loss of blood.

CAUSES.—The causes of shock are *psychical* and *physical*, external and internal. They may act singly or conjointly.

Psychical.—The influence of the mind over the organic functions of the body is very remarkable. The action of the heart is increased by the emotion of joy, diminished by grief or despair. A strong mental impression sometimes disturbs the function of the liver and induces an attack of jaundice. The stomach may become deranged, the secretion of the kidneys suspended or increased, and the milk of the nursing mother rendered entirely unfit for use, from emotional causes. Numerous instances of sudden death have followed the announcement of both joyful and depressing news. Nothing more fully exemplifies the intimate interdependence of mind and body than the rapidity with which a patient sinks who has been the subject of a mortal injury, but who, ignorant of its true nature, has been buoyed up by hope until the conscientious physician, constrained by a sense of duty, informs the sufferer of the near approach of death. Criminals, whose eyes have been bandaged, and who have been informed that they were to be bled to death, are said to have died under the impression that the operation was being performed, although not a drop of blood was lost. A slight scratch made over a vein, and a little stream of water falling audibly into a basin, were sufficient to counterfeit the opening of a vessel and the flow of blood.

Physical.—Among the physical causes of shock may be enumerated, as most prominent, falls, blows, injuries of the head, of the spine, and of large joints, railroad and machinery accidents, gunshot wounds, burns, and scalds.

Doubtless, in most instances of violence both the mind and the body are concerned in producing the symptoms of shock. The fright incident to the injury, the horror of impending destruction, must, independent of the physical harm or lesion, constitute a powerful source of depression. This, perhaps, is most noticeable in railroad collisions, in which many persons, though at first unconscious of having sustained any bodily damage, fall into a condition of fatal collapse after the period of excitement has passed over.

There are also internal causes which are as potential in causing shock as any external traumatic violence, such as the passage of a biliary or renal calculus, the perforation of the stomach or intestine by cancerous ulceration

or from the effects of enteric fever, a developing peritonitis, the serous discharges of cholera, and a strangulated bowel. Severe pain may also bring on a fatal collapse.

Intensity of Shock.—The severity of shock depends on a variety of conditions.

(1) *Constitutional peculiarities, mental and physical.*—A timid or cowardly person, exposed to some sudden accident, will, even though the bodily injury may be slight, suffer a more serious prostration than one who is fearless and indifferent to danger.

Travers relates the case of a colored man received into the London Hospital suffering from a moderate-sized aneurism of the femoral artery. When the patient was introduced into the amphitheatre for the operation, he appeared agitated, and fainted; and before the ligation was completed he was dead.* The same writer adduces the case of a man who, being seized with a strangulated hernia, expired from fright before the preliminary measures necessary for the operation were completed. The autopsy showed that there was nothing in the condition of the bowel to explain the death.

Again, there are persons who are in no way deficient in boldness and courage, who, upon sustaining a trivial injury, are seized with tremblings, faintings, stupor, and frightful exhaustion. Sir Astley Cooper mentions the instance of a strong, vigorous man who had been suffering for some days with an abscess of the finger, caused by a splinter of wood. An incision was made to give vent to the matter, when the patient raised himself from the bed in a convulsive manner and immediately expired. Such results can only be explained on the theory of some individual peculiarity or idiosyncrasy of organization.

In contrast with the above is another class, of a cold, phlegmatic temperament, hard-grained persons with iron nerves and coarse muscles, defiant of pain, who endure all forms of mutilation with apparently little sensibility or depression.

(2) *The diffused nature of the injury* has also much to do with the production of shock. A scald or a burn becomes serious, both as regards shock and prospective inflammation, more by the extent of surface involved, however superficial the lesion may be, than by its depth when the damage is more limited.

A leg or an arm may be hopelessly mangled or crushed, and yet, if the effects of the violence are confined to the injured part, there will probably be but a slight or temporary depression of the general vitality, unless the constitutional factor of a peculiarly sensitive organization comes in to intensify traumatic effects. On the other hand, if the body has been included in the injury, as often happens in railroad and machinery accidents, the shock will be prominently marked.

Many cases of instantaneous death are the result of diffused or general concussion of the body.

(3) *The organ or region of the body implicated.*—A severe contusion of the testicle, or a rupture of an intestine, is attended with much greater prostration than a wound of the brain. A blow delivered upon the abdomen produces a much more depressing effect on the nerve-centres than a similar violence inflicted on the chest; and a fall upon the head will be followed by a more pronounced shock than that which succeeds to a crushed upper or lower extremity. The same is true of the extirpation of tumors situated in the deep regions of the neck, as compared with the removal of similar growths of much greater bulk in less vital regions of the body. The avulsion of a toenail causes a greater shock than the removal of the mammary gland. The crush of a joint, like that of the knee, is productive of a greater shock to the system than a similar injury of the thigh,—a fact probably explained by the complex nature of an articulation.

* Travers on Constitutional Irritation, p. 23.

(4) *Kind of injury.*—All wounds or injuries are not alike productive of shock. Incised wounds, if the hemorrhage is promptly arrested, occasion less constitutional depression than lacerated wounds. A missile may carry away a portion of the skull and its contents, and yet cause less shock than a force which fails to fracture any part of the cranium.

(5) *Loss of blood.*—If, in addition to the injury, there follow an excessive loss of blood, the symptoms of shock are intensified by the dangerous complication of *syncope*, which stands in relation to the vascular system very much as shock does to the nervous system. It is owing to this loss of blood that so many persons who are brought into our hospitals with crushed limbs never rally from the injury.

(6) *Age, and habits.*—The extremely aged and the very young possess little power to resist the depressing influences of external injury; and those who by a life of vicious excesses of any kind have enfeebled the body are alike vulnerable.

Nature of Shock.—How the violence or the emotion acts upon those central ganglionic masses of neurine whose office it is to sustain and regulate the functional operations of organs, is a question which physiology has not answered. Considered from a clinical stand-point, it is evident, first, that the determining cause of shock must reach that portion of the nervous system through either the spinal, the cerebral, or the cerebro-spinal nerves, from which the heart and the lungs receive their motor endowments; for the feeble action of these organs is one of the first observed phenomena of shock.

Some very interesting observations were made on this subject during the late war by Drs. Mitchell, Morehouse, and Keen, of Philadelphia, from which they infer that the medulla oblongata and the pneumogastric nerves are chiefly concerned in bringing about the cardiac and pulmonary conditions. But we must not stop here. The central factor in shock is not circumscribed by the limits of the medulla oblongata; it embraces a wider domain of the cerebro-spinal system, including those sections, with their communicating nerves, which preside over the secretions of the various organs, which energize the muscles of animal life, and which affect both common sensibility and the special senses, all of which are functionally disturbed. Nor can the vascular phenomena be satisfactorily explained without including the centre of the entire vaso-motor system of nerves, whether that centre lie in the medulla or in some other part of the spinal cord.

By associating together feebleness of the heart and paralysis of the walls of the blood-vessels, we can explain the accumulation of blood in the deep venous trunks. The slight fall of temperature which is so often observed in shock would seem to be due to the temporary arrest of tissue metamorphosis, occasioned by the defective innervation.

Secondary or Remote Effects of Shock.—The evil consequences of shock do not always terminate with the disappearance of its symptoms. They may be witnessed long after what seems to be a perfect recovery; while not a few complain of never being the same persons after escaping from the immediate consequences of an injury. The gravity of these alleged remote effects is often out of all proportion to the original injury. These sequels appear either in the nervous or in the nutritive system. Under the former may be noticed muscular weakness, irregular or choreic movements, defective memory, and wakefulness. In one instance, a young man who had been very severely injured by falling between a platform and a passenger-car suffered greatly both in body and in mind from his inability to secure a protracted rest. The moment he fell into a sleep he was aroused in a fright with a start, under an impression that he was falling under the cars. The hallucination continued as long as he lived, and, I believe, hastened his death. Others, again, suffer from disturbances of the digestive organs, in consequence of which they become anæmic and lose flesh and strength. In some instances, persons

who have at some previous time sustained a severe injury die suddenly, and their death is referred to traumatic cause. I will not deny that in many of these cases there is really a connection between the injury and the evil complained of; but it must be apparent that there is large room for error on this point.

Prognosis.—If, after the lapse of a few hours, the pulse begins to increase in force and becomes more regular, showing that the energy of the heart is returning,—if the ashy pallor leaves the face and the respiration is performed with greater freedom and fullness, now and then broken by a full-drawn sigh, the indications point to a favorable termination of the case. If to these signs there is added an improved temperature of the skin, with a disposition on the part of the patient to turn on the side, to draw up the limbs, or to change the posture in any way from that of the dorsal decubitus, the prospects of recovery are still more favorable. The supine position indicates extreme muscular weakness, and any change which a patient is able to make is an evidence of increased power.

On the other hand, it may be said that the longer reaction is delayed the greater is the danger. Every hour after twenty-four tells against the patient. A very slight fall of the temperature below what is normal—even one or two degrees—is an omen of evil; and the same may be said when the temperature is materially increased. Few persons ever rally in whom the heat of the body falls to 96° or rises above 103° .

When the reaction begins, should the temperature exceed 103° there is ground for anxiety, especially if the rise occurs after the lapse of thirty-six hours. Should there be, however, after the elevation, a steady decline of the heat to 98° , or the health standard, it argues a salutary tendency in the disease.

Any concomitant injury to the abdominal viscera, or to the contents of the cranium, confers additional gravity on the case. The same is true when there is the further complication of hemorrhage; for there is added to the exhaustion from failure of nerve-power a depression from syncope. The existence of renal disease will also weigh against the recovery of a patient from shock.

Post-mortem.—If the death from shock has been sudden, the heart is sometimes found almost entirely empty, as though the last act of the organ had been one of spasmodic contraction.

The opposite condition, however, is the more common, especially when death has been gradual in its approach, the right auricle and the right ventricle being found distended and filled with loose blood-clots. The intestines are also distended,—the result of defective innervation. If food has been taken a short time before the occurrence of shock, it will be found unchanged in the stomach, digestion having been entirely suspended. If the patient has urinated a short time before the accident, the bladder will contain a very small amount of urine. The engorgement of the deep venous trunks usually witnessed follows from the failure of power at the centre of the circulation.

Modes of death.—There are, consequently, four modes of death from shock: *first*, by a total suspension of innervation, in which death is instantaneous; *second*, by exhaustion, following upon a partial or incomplete suspension of nerve-force, the fatal termination coming on gradually; *third*, by the loss of nerve-force and the loss of blood conjointly; and, *fourth*, by exhaustion following excessive reaction.

Treatment.—In very slight cases of shock, nature requires little if any assistance from the surgeon. The patient must be placed in the recumbent position, with the head low; and a little strong coffee may be administered, or some diffusible stimulant, such as the carbonate of ammonia. The depression is evanescent, and passes quickly over, leaving the patient unharmed.

Not so, however, with those cases in which the symptoms are well pro-

nounced. Such demand the most judicious attention. The immediate danger consists in the failure of the heart-action, and this must be counteracted by the use of such agents as will sustain the power of this organ. With this object in view, stimulants are generally administered, and often poured recklessly into the stomach. It must be remembered that the function of absorption in that organ is almost wholly suspended in severe shock; and if stimulants are then given in large quantities they may accumulate, and work great harm when reaction does take place, by lashing the heart into action so violent as to induce a secondary depression more dangerous than the first. Fortunately for the patient, they are often thrown off by the vomiting which so frequently attends shock.

In my judgment, stimulants are utterly useless during the early stage of shock. The time for their administration is when the signs of reaction begin to appear. They are then absorbed, and, if cautiously used, will give to the heart a timely aid, preventing that fatal relapse from cardiac exhaustion which often occurs. Brandy and whiskey are the best, and should be given in small quantities, not exceeding a teaspoonful at a time, and at intervals of twenty-five minutes or half an hour. If the patient cannot swallow, they may be administered by the bowel. Stimulants act promptly, in cases of shock, when used hypodermically. Half a teaspoonful of good brandy may be introduced into the subcutaneous cellular tissue at several points with the hypodermic syringe, and this operation may be repeated according to the urgency of the case.

External warmth is of the utmost importance, and should take precedence of all other remedies. It should be addressed to the head, the body, and the extremities. A rubber bag partly filled with hot water, or towels wrung out of the same, may be applied to the head; bottles containing hot water, or heated bricks rolled in flannel cloths, should be placed along the spine, the sides of the body, and the limbs; while over the epigastrium may be placed with advantage a sinapism of mustard. Volatile substances, such as ammonia, may also be held to the nose, as a means of exciting the respiratory movement. Dr. Hunter, of this city, suggests placing the patient in a hot bath.

Nourishment, in the form of milk, hot coffee, or warm beef-essence, may be given in small quantities whenever reaction begins and the stomach will tolerate its presence. When the patient has lost much blood, this becomes a very important part of the treatment.

In extreme cases of shock, where the respiration of the patient is fast failing, everything depends on maintaining the action of the heart. To this end artificial breathing must be diligently and persistently practiced.

As the venous engorgement on the right side of the heart, so commonly seen in cases of collapse, resists the contraction of the right ventricle and auricle, and enhances the danger, Mr. Savory has advised the abstraction of blood in order to relieve the over-distended organ. The suggestion is a rational one when there has been no precedent hemorrhage and the condition can be clearly determined. Distention of the superficial veins of the neck is the sign of this venous engorgement, and, when present, the external jugular may be opened.

When the depression is intensified by the loss of blood, the cephalic extremity of the body must be lowered, the limbs bandaged from below upwards, and the abdomen compressed in order to force the blood from the portal veins towards the brain. Warm water, saline solutions, or milk thrown into the bowel will serve to replenish the vessels, and to counteract the exhaustion. Whenever the pulse, the temperature, and the color begin to improve, nourishment, provided the stomach will retain it, is of infinitely greater importance than are stimulants. The latter, it will be perceived, have their true application during that short period which intervenes between the first dawn of reaction and its near completion. The indications now are to lessen excessive action and to sustain power. For this object our most valuable resource is opium with digitalis. Twenty-five

or thirty drops of laudanum with ten drops of digitalis may be given by the mouth. Or, if the stomach proves to be irritable, a suppository, consisting of two grains of opium with the same amount of hyoseyamus, should be introduced into the rectum; or a quarter of a grain of morphia may be administered hypodermically.

When the reaction is accompanied or followed by any of the forms of delirium which have been described, the anodyne treatment is still more imperatively required; and, in addition, an ice-bag may be applied for a short time to the head.

The irritability of the stomach sometimes becomes so prominent a symptom after reaction as to demand special attention. To allay this irritability, a tablespoonful of mint-water, containing half a drop of carbolic acid and half a drop of dilute hydrocyanic acid, should be given, and a mustard-plaster placed over the epigastrium. Small pieces of ice placed in the mouth and allowed to dissolve are very efficacious in allaying the thirst from which the patient suffers. When the delirium is of such a nature as to render it necessary to employ restraint, the wrists and ankles of the patient should be made secure to the bed by roller bandages, if the more elaborate hospital apparel is not at hand.

In those cases in which collapse and reaction are contending for the mastery,—that is, where reaction has become measurably established and then recedes,—the surgeon must not be too anxious to interfere. He had better become an attentive spectator, and take sides only when the enemy seems to have the vantage-ground.

OPERATIONS DURING THE EXISTENCE OF SHOCK.—The propriety of performing an operation during the condition of shock is a subject which requires the most cautious consideration.

There can be no objection to adjusting a broken limb, the malposition of which must, by causing pain, add to the severity of the shock. Nor would it be wrong to control the hemorrhage of a wound, even if in doing so it became necessary to cut down upon and expose a large arterial trunk. The collapse which sometimes follows incipient strangulation of an intestine can be no bar to performing an operation for the relief of hernia, as only by so doing can we hope to remove the shock. The same may be affirmed with regard to a compound depressed fracture of the skull with shock: the bone should be elevated as an essential part of the removal of collapse.

With reference, however, to the performance of an amputation, or to the excision of a joint after a compound luxation, the course to be pursued is somewhat different. To operate when there are no evidences of reaction from the collapse is to add injury to injury; and until reaction takes place, as a general rule, the knife must be withheld.

There are some who think that in prolonged shock, rather than allow the case to pass beyond the limits of the primary period, it is better to operate, even during imperfect reaction, especially as the patient may be spared all pain by the use of an anæsthetic.

There can be little doubt of the correctness of this opinion. The ether does more in such cases than prevent pain: it really imparts tone to the heart, and favors rather than retards the progress of reaction. The great point in these cases is that the surgeon shall have a reasonably well-grounded assurance that what reaction does exist is sufficient to withstand the effects of the operation which he is about to perform.

Traumatic Infective Fever.

It is often difficult to invent terms which will convey exact ideas of pathological conditions. Under the head of *traumatic infective fever* I shall treat of fever following injuries and operations, and which I believe to be due to the introduction into the blood of certain subtle septic matters which are the products of tissue-decomposition. Among the various names which have

been given to the morbid phenomena may be mentioned phlebitis, pyæmia, pyohæmia, septhæmia, septicæmia, septæmia, septopyæmia, ichorhæmia, purulent absorption, pyogenic diathesis, metastatic or multiple abscess, thrombosis, surgical fever, surgical typhus, and suppurative fever.

Simple Traumatic Infective Fever.—In all cases of any considerable operation or injury, after the lapse of from eight to thirty-six hours the patient presents the phenomena of fever, which has been designated "*wound fever*," "*surgical fever*," and "*traumatic fever*." It is sometimes ushered in by a short period of restlessness. The patient complains of being hot, the face becomes flushed, the skin is dry, and these symptoms are accompanied with thirst, loss of appetite, and not unfrequently headache. The tongue is also coated, and the pulse is increased in frequency over the natural standard. Should the febrile excitement run high, there may be some confusion of the intellect, with slight delirium. The secretions are usually disturbed, the mouth being dry, the bowels costive, and the urine scanty and high-colored. Not unfrequently the febrile symptoms are inaugurated by a rigor or chill. Should the fever continue for any considerable time, it assumes an intermittent type, with regular morning and evening exacerbations. Usually, however, in a short time, varying from a few hours to two or three days, the fever begins to subside, the pulse is lessened in frequency, the temperature falls, the thirst abates, the secretions return to the mouth, the skin is covered with a gentle moisture, and the urine becomes more abundant, furnishing a free deposit of urates.

The temperature rarely exceeds 102° or 103°; though I have seen it as high as 105°.

The intensity of the fever is usually in proportion to the severity of the injury. A large allowance, however, must be made for constitutional peculiarities. There are many persons who, on the reception of very slight injuries, experience high constitutional disturbance, while others, of a more phlegmatic and gross organization, endure severe injuries or operations with comparatively little disturbance of the circulation.

The causes of surgical infective fever must be sought for in the wound, or at the seat of injury. It is true that the shock sustained by the system may exist in some degree as an element in causing the subsequent excitement. But when it is remembered that, even after wounds or injuries so slight as to cause no depression, nervous or circulatory, severe febrile symptoms may ensue, it must be evident that this condition can play but a very subordinate rôle in causing the fever. Very soon after an individual has suffered from traumatic violence, important changes set in at the seat of injury. The vitality of the damaged tissues is destroyed to some extent, and these devitalized fragments undergo decomposition, while around them there is taking place the rapid tissue-change incident to an inflammatory process. The products of these chemical and physiological actions, intermingled with the blood serum which flows into the parts about the wound, must be disposed of. A portion will escape through the wound, and, when the latter communicates with the surface, will be imbibed by the dressings. Another portion enters the veins, and probably also the lymphatics, and is in this way turned into the blood-vessels. The admixture of this sewage with the blood so alters the quality of the latter that it becomes an irritant to the cardiac ganglia, thereby exciting the heart-action; and the rapid interchange of tissue, referable to the inflammation, is attended with the production of an unusual amount of heat, which explains the high temperature.

TREATMENT.—During the period of traumatic fever the symptoms will be moderated by the use of refrigerants, such as the neutral mixture, containing a very small amount of morphia, or by administering from time to time some sweet spirit of nitre. Cold drinks will also prove both grateful and valuable; and, while it is not necessary to purge the patient, the bowels should not be allowed to remain constipated. After the disappearance of the fever, the

system is left in a feeble, depressed state, demanding the use of a good diet, tonics, and stimulants.

Secondary Traumatic Fever.—A patient may pass through the usual disturbance of surgical fever and all the symptoms quietly disappear, and yet, a few days later, he may have a renewal of the attack. An occurrence of this nature should be always regarded with anxiety. It is often ushered in by a chill, and is frequently the outcome of an inflammatory invasion of some part or organ of the body. It may be an abscess situated in the cellular tissue, more or less remote from the seat of operation, or it may be caused by the involvement of some portion of the thoracic or abdominal viscera. If the fever continues for several consecutive days without abatement, and there is a recurrence of chills, great apprehension for the safety of the patient may be entertained. The most rigid examination and interrogation of every organ should be instituted, in order to ascertain the location of the disease; and, when it has been traced to its proper source, the treatment must be conducted on general principles applicable to the case.

Should the febrile paroxysm assume an intermittent type, it may be referred to miasmatic influences which have remained dormant in the system and have been called into activity by traumatic shock. This is especially likely to be true if previous to the operation the patient has been exposed to the atmosphere of unhealthy localities. Full doses of quinia will generally suffice to break up the fever and establish convalescence.

This secondary fever may partake of the nature of hectic, and seriously complicate the success of an operation. It may be developed by a profuse or tedious suppuration, or by a phlegmasia of the pulmonary or renal organs.

The efforts of the surgeon under these circumstances must be directed to the support of the system by food, tonics, and stimulants, and, when the suppuration is external, by adopting such measures as will arrest the formation of pus, secure the consolidation of the parts, and, by establishing the most perfect drainage, prevent purulent infiltration.

Complicated Traumatic Infective Fever.—In this variety of the disease, in addition to an adynamic type of fever there are present various inflammatory changes of a secondary nature in different organs and tissues of the body, in the form of multiple abscesses and sero-purulent formations in the serous and synovial cavities. The terms pyæmia and septicæmia are generally employed to express this type of surgical fever.

The term *pyæmia*, derived from two Greek words, *πύον*, "pus," and *αἷμα*, "blood," originated with Piorry, a French physician, and signifies *pus in the blood*. Allusions to the disease may be found in several of the older surgical writers, among them Ambrose Paré and Guthrie, who had observed a similar relation between a certain class of wounds and abscess of the spleen. It is only, however, of late years that anything approaching the true pathology of this complicated traumatic infective fever has been ascertained. For this knowledge we are chiefly indebted to the labors of our French and German brethren, and, among the latter, notably to Virchow.

For the solution of this pyæmic problem several theories have been propounded. These may be classified as the *purulent*, the *thrombotic or embolic*, the *miasmatic*, and the *septicæmic*.

PURULENT.—By the *purulent theory* is meant the theory which attributes the fever to the introduction of pus into the blood. In considering this theory, two questions arise,—what are the routes by which pus can enter the circulation, and what effect is produced on the general system by the admixture of pus and blood? There are three ways by which it would appear that pus can enter the circulation, viz., by the veins, by the lymphatics, and by the arteries.

(1) *Entrance by the veins.*—It is after operations in which these vessels are divided that this intrusion is said to take place. The conditions for such ad-

mission, if it ever does occur, are most favorable in injuries or wounds which open the cancellated tissue of bones, and where, in consequence of the size of the venous trunks and their surrounding connections, the complete collapse of their walls is prevented. The very common occurrence of pyæmic symptoms after such injuries is apparently corroborative of this view: I say apparently, since there are no facts which raise this statement above the region of conjecture. I cannot believe that pus, as such, reaches the circulation in this manner. After the division of a vein, its walls, particularly when surrounded with soft parts, fall together, and are soon closed by a clot or by adhesive inflammation, either of which would offer an impenetrable barrier to the intrusion of pus-cells. There is, moreover, no circulation in that part of the vein which is in nearest relation to the wound.

An abscess may form in some portion of the body, or a wound may be inflicted, and, from inflammatory adhesion, the walls of the one or the sides of the other may become united to a contiguous vein. Ulceration may subsequently set in and form a communication between the two, and in this way pus may pass directly into the venous current. I have seen an abscess of the arm open into the cephalic vein after this manner.

Another way in which pus was thought to enter the veins was by phlebitis,—a doctrine which was warmly espoused by John Hunter, Guthrie, Abernethy, and Liston. This was also the theory of Dance, based by him on what he had observed in uterine phlebitis occurring in puerperal women. It received the support of Cruveilhier, and was more thoroughly elaborated by this investigator and by Blundin. The objections which may be urged against this theory are the want of uniformity in the position of the inflammatory products (being oftener external to the inner tunic of the vein than within the latter, or, if within the vessel, being incarcerated in the midst of the coagulum which succeeds the phlebitis), and the fact that the pyæmic condition may exist independent of any inflammation of the veins whatever.

(2) *Entrance by the lymphatics.*—Another system of vessels communicating with the circulation is the lymphatic. These are necessarily opened in operations, in the same manner as the veins, or they may themselves become the subjects of suppurative inflammation,—in either event offering an avenue for pus. But it is exceedingly improbable that pus can ever reach the blood-stream through these channels. The lymphatics, on their way to the thoracic duct, do not pass through the lymph-glands, but terminate in them. These glands are known to arrest substances of smaller dimensions than the pus-corpuscle, —*e.g.*, the finest particles of coloring-matter. Indeed, one of the offices of the lymphatic glands is to intercept substances which are calculated to prove prejudicial to the body should they reach the circulation.

(3) *Entrance by the arteries.*—The third route for the entrance of pus into the blood is through the arteries. This may occur by ulceration of their walls. The thoracic aorta may be the subject of aneurismal dilatation, and, by its pulsation, excite inflammation and partial absorption of the vertebrae against which it rests. The irregular or spiculated fragments resulting from these changes in the bones may cause ulceration in the walls of the vessels, and thus open a way for the entrance of pus. Or the same thing may follow upon a suppurative arteritis, the purulent matter finding its way into the cavity of the vessel.

Velpeau and others have attributed the pyæmic phenomena to the absorption of pus. But there is no evidence, physiological or pathological, to sustain such an inference. Pus, as such, is never absorbed. It is true that in some instances the contents of an abscess may disappear without being discharged externally, and the development of hectic symptoms as the result of suppuration is a familiar event. But in neither case does the pus-cell enter the blood. Before the pus-cell can be absorbed, it is necessary that it shall undergo a transformation by which both its form and its chemical characteristics are materially changed.

The unity of the pus-corpuscle and the leucocyte is the accepted doctrine

of the present day; and it may be said that a body whose native habitat is the vessel, on escaping, could not exert a poisonous effect when returned again to the blood. This, however, is not a fair deduction from the premises, as it cannot be supposed that after migration the pus-cell, however recent, continues to retain the same physical and chemical constitution that it had before it left the vessel.

The argument in support of the purulent theory, drawn from the presence of pus in the blood of patients who have died from the form of infective fever under consideration, is also open to the serious objections that no distinction can be made between the two corpuscles, and that the bodies noticed in such large numbers in the blood of pyæmic patients, and affirmed by many to be pus-corpuscles, are probably, as stated by Virchow, leucocytes, which have been greatly multiplied by the irritation of the lymphatic glands, the condition answering to the leucocythæmia of Bennet.

EFFECTS OF PUS IN THE BLOOD.—In order to determine the effect of introducing pus into the circulation by artificial means, numerous experiments have been instituted by different observers, among whom may be mentioned Gaspard, Magendie, Sédillot, Polli, and Callender. The results varied in different experiments.

Generally, when fresh pus was thrown into the veins of healthy dogs, the animals, though exhibiting symptoms of constitutional disturbance, recovered after a few days of indisposition. The repetition of these injections, however, or the introduction of a considerable quantity of putrid pus into the blood, usually caused the death of the animals.

The anatomical appearances which were noticed consisted sometimes in the formation of soft clots; in other instances the blood was found separated into its different components and disorganized. Secondary deposits, or abscesses, were frequently seen in the venous capillaries of the lungs, together with gastro-intestinal symptoms.

Other experiments were performed by injecting liquid infusions of different putrid substances, both animal and vegetable, with results not differing materially from those obtained when pus was introduced.

It should be noted that in the so-called pyæmia there are two distinct factors, a local and a general one. The first is seen in the secondary deposits, or metastatic abscesses, which form in the pulmonary, hepatic, and other capillaries, and which are considered by many to be the result of obstruction, while the second is expressed by the toxic symptoms characterizing infective fever. It is essential to the proper study of this subject that these two conditions be kept clearly in mind. Bérard, in his paper on purulent infection and putrid infection, had evidently this distinction in view; and the same is true of those who distinguish between pyæmia and septicæmia. Pus, in its chemical constitution, is an exceedingly complex substance, containing a large amount of organic matter. The products of decomposition, such as ammonia, sulphuretted hydrogen, butyric acid, tyrosin, and other substances, when introduced into the circulation, cannot fail to produce serious alterations of the blood. It is by no means proved that the solid portion of pus becomes aggregated so as to blockade the capillaries and excite a local suppurative inflammation, occasioning the multiple or secondary abscesses. The septic materials resulting from the decomposition of its less stable constituents, being diffused through the whole mass of the blood, will unquestionably not only develop a putrid fever, but may produce also the local phenomena.

THROMBOSIS AND EMBOLISM.—This is the doctrine of Virchow, and one which has been accepted by the most prominent German pathologists. It has been enunciated in a less formal manner by Darcet, of France. Thrombosis or coagulation of the blood may be determined by various causes, among which may be mentioned change in the constitution of the blood, phlebitis, roughness or irregularities on the inner surface of the vessel, and retardation of the blood-stream.

By change in the constitution of the blood are meant such alterations as are

induced by the introduction of septic substances into the vessels, by the separation of the fibrin with the albumen from the other constituents of the fluid, and their deposition on some portion or portions of the lining membrane of the vessels. If fibrin, as alleged by Schmidt, does not normally exist in circulating blood, this latter explanation must be abandoned; though Schmidt's hypothesis does not exclude the idea of coagulation by the catalytic influence of some ferment which is present.

In thrombosis, attended by symptoms of inflammation, it is not always possible to say exactly how the two processes are related to each other,—that is, whether the phlebitis determined the coagulation, or the coagulation caused the phlebitis,—as both, undoubtedly, do in many instances occur. The thrombosis, however, which is so peculiarly related to pyæmia is that which is due to an antecedent wound. The formation of a clot in the saphena vein is not an uncommon occurrence in typhoid, scarlatina, and other fevers in which the blood has been profoundly altered; yet pyæmia as a consequence of such coagula is almost unknown. Embolism of arteries frequently takes place, and may be followed by gangrene in the parts belonging to the distribution of the obstructed vessel, but not, generally, by the signs of purulent infection.

The *theory of thrombosis* is, that a clot of blood forms from some cause in a vessel, for example, a vein. This clot may increase by additional deposits until it rises to a point on a level with, or even above, that where a collateral branch enters the obstructed vessel. The blood-stream, as it passes along, detaches a portion of the clot, or the coagulum spontaneously begins to disintegrate, and the fragments are borne onward in the current to the right side of the heart, and finally through the pulmonary artery to the venous capillaries of the lungs. Some of these fragments are arrested in capillaries of the first order, while others—particles of smaller dimensions—may slip by into those of still smaller size. The presence of these foreign bodies, blocking up the vessels, provokes a suppurative inflammation within the territorial limits of the obstructed capillary, forming what are called secondary deposits or multiple abscesses.

There is, however, a pathological fact known to exist in the disease under consideration, which is not satisfactorily explained by the theory of embolism, except by admitting that there may be embolic particles so exceedingly small as to pass through the pulmonary capillaries. I refer to the absence in some cases of pyæmia of any secondary deposits in the pulmonary capillaries, while at the same time they are present in other viscera, as the liver and the spleen. Weber admits this passage for certain portions of pus, and I can conceive of no insuperable objection, based either on the divisibility of matter or on the anatomy of the capillaries, to allowing a similar passage of a fragment of clot from the venous to the arterial system. The untenability of the explanation lies in this, that it seems incredible, on the above theory, that all the embolic fragments (for there must be many) should be so infinitely small as to pass from the pulmonary arteries to the pulmonary veins.

MIASMATIC ORIGIN.—The advocates of the miasmatic origin of pyæmia, I presume, mean the presence in the air of certain septic materials, which, when brought into contact with an open suppurating wound, are competent to cause systemic infection. The dust which floats in the atmosphere of a filthy and badly-ventilated hospital ward in which are many suppurating sores may acquire very dangerous qualities from being charged with the products of decomposition. The propagation of hospital gangrene through the medium of the air needs no confirmation in the light of present experience.

It is even supposed that intangible poisons or miasms may find their way into the blood through the lungs and develop signs of purulent infection. But, if this be true, it may be queried, why should not some persons without wounds, who breathe the same air, suffer alike with those who have suppurating sores? In cases where persons are suffering from suppurating injuries

of either the bones or the soft parts, it is not unreasonable to suppose that the inflammatory products may be increasingly vitiated by the operation of subtle poisons which are capable of disturbing a proper blood-formation, by acting on the blood and rendering it unfit for the purpose of repair or for the nutrition of tissues. In no other way do I suppose that miasmata can exercise through the lungs any influence in originating pyæmia.

SEPTICÆMIA.—The fourth theory for the production of complicated traumatic infective fever is that of septicæmia; that is, the introduction into the circulation of some subtle, intangible septic poison, the product of putrefactive changes in the solids and fluids of the damaged parts, so modifying the blood as to favor the formation in the capillaries of obstructive coagula, which, acting as irritants, originate foci of suppurative inflammation, or multiple abscesses, and diffuse inflammations both in serous and synovial membranes. This is the only theory that is adequate to account for all the phenomena of pyæmia.

The whole subject of traumatic infective fever may, therefore, be formulated as follows: *first*, a general disturbance of the system, as expressed by the symptoms of fever; *second*, the occurrence of local and diffuse inflammation, followed by multiple abscesses, and by sero-purulent transudations into the serous and synovial cavities.

Morbid Anatomy.—An examination of the bodies of those dying from traumatic infective fever reveals very extensive and wide-spread alterations of structure, the most notable of which are numerous abscesses in different organs and tissues of the body, and, not unfrequently, accumulations of purulent fluids in the serous cavities and in the joints.

Lungs.—These points of suppuration, multiple or metastatic abscesses and secondary deposits, as they are called, are most frequently met with in the lungs, and, according to Callender, oftener in the left than in the right lung. They may be few in number, or they may amount to many hundreds, and are seen of all sizes, from the size of a millet-seed to that of a walnut, and in every part of the organ, especially in the posterior part of the lower lobes of the lung. These nodules vary in color, which depends in a great measure on their age. They may be red or reddish brown, gray, yellow, or dark brown,—shades which are significant of the inflammatory stages through which the patches are passing, in most respects answering to the red and gray hepatization, suppuration, and gangrene observed in the course of a pneumonia. In truth, the disease is one of circumscribed or lobular pneumonia. When laid open, they are found to consist of a cavity formed at the expense of the parenchyma of the lung, and containing pus, together with minute fragments of disorganized pulmonary tissue. Some of these patches, when cut into, appear to be of comparatively recent formation, as they contain a very small amount of pus with considerable granular matter. When the nodules present a very red appearance, they form the so-called *red infarctions*. Secondary pleurisy is often present, and is most probably induced by a propagation of inflammation from these patches of multiple abscesses, which lie near the surface of the lungs. The pulmonary organs, from their relation to the venous system, are much more frequently the subjects of infarctious abscesses than the other internal organs; according to Sédillot, ninety-nine times in a hundred cases of the disease.

Liver.—The liver suffers next in frequency to the lungs. Discolored spots—generally dark red—may be seen scattered through the organ. The inflammatory patches undergo softening much more rapidly than those of the lungs; and indeed the hepatic tissue for some distance beyond the limits of the abscesses is abnormally red, soft, and friable. About 25 per cent. of the cases of traumatic infective fever implicate the liver. The uniform connection between suppuration of this organ and injuries of the head, of which so much has been said, I have never observed.

Spleen.—This organ is uniformly enlarged, and is altered in both form and

consistence; and when it is the subject of secondary deposits it presents indurated masses or nodules of an oblong or cuneiform shape, which, when opened, are seen to be abscesses. Each abscess is surrounded by a vascular zone. Nor is the structural alteration confined to the neighborhood of these deposits of pus; indeed, the entire gland, as well as its pulp, is softened and easily broken down under pressure.

Kidneys.—The renal organs are affected in the same manner as the lungs and liver, though not with the same frequency. Numerous patches of suppuration are met with through the substance of these organs, each being invested with a circle of congested blood-vessels. When the disease follows an operation on the genito-urinary organs (for example, that of lithotomy or of perineal section), these organs are particularly prone to the formation of abscesses.

The prostate and testes are not exempt from similar inflammatory changes, though the latter are much less common in these parts than in the lungs and liver.

Heart and brain.—The heart and brain occasionally suffer in common with the other organs, exhibiting spots of local inflammation, with suppuration situated near the surfaces, or immediately beneath their serous coverings.

It may readily be supposed that inflammatory changes situated in the peripheral portions of organs may easily extend to the membranes which surround the same; and hence pleuritis, peritonitis, pericarditis, and arachnitis in numerous instances follow in the course of the disease with purulent formations in their cavities.

Joints.—Continuity or proximity of structure will not, however, explain the purulent transudations met with in joints. We must, therefore, refer these cases of synovitis to the state of the blood. Bryant has noticed a singular preference of the disease for the sterno-clavicular articulation. In my own experience the ankle or the knee has most frequently suffered. The morbid changes which are noticed in joint complications accompanying the fever are opacity of the synovial membrane, increase of its secretion, the presence of unhealthy pus, the loss of the pearly, glistening appearance of the articular and interarticular cartilages, and, occasionally, even the disorganization of the latter, with caries of the underlying ends of the bones.

Nor are these inflammatory transudations confined to the internal organs and to the serous and synovial membranes alone. They are seen in the *skin*, in the *subcutaneous tissues*, and in the midst of the *muscles, lymphatics, blood-vessels, thyroid gland, and tongue*.

These purulent collections which are found in the muscles present generally the characteristics of laudable pus, without any infiltration or surrounding vascularity, such as belongs to an ordinary acute abscess, or even to those abscesses which have been described as existing in the internal organs.

Eruptions of a pustular character, and hemorrhagic patches, with purple discolorations, appear on different portions of the body and the limbs. Jaundice, to a greater or less degree, is quite a common occurrence, depending probably on some structural alteration of the liver.

Not only does the entrance of septic matter into the lymphatics excite inflammation of these vessels, but, as their contents are poured into the lymph-glands, the poisonous material may there be detained and give rise to a suppurative adenitis. It is the irritation of these glands which, according to some writers, accounts for the multiplication of leucocytes seen in the blood in this fever, and which were once supposed to be pus-corpuscles. When there have been gastro-intestinal or intestinal symptoms present, both the agminated and the solitary glands are found congested and swollen.

Inflammation of the veins is not very common in complicated traumatic infective fever, notwithstanding the prominence once given to phlebitis as the radical element in pyæmia. When it does exist, the walls of the inflamed vessel become thickened by infiltration and its cavity obstructed with coagula, —a result, not a cause, of the disease.

Little can be learned from an examination of the blood of pyæmic patients. The most searching chemical and microscopic observations fail to detect anything which can be identified as the disturbing agent. The relation which minute organisms, like bacteria, found in the blood of infected persons bear to the change in the constitution of that fluid is mere matter of conjecture. The property of coagulation, though not lost, is certainly lessened, and the color of the venous blood appears to be considerably darker. In a few instances patients die of complicated traumatic infective fever in two or three days from the commencement of the attack, and when the autopsy is made there are no morbid appearances found adequate to explain the cause of death. In such cases it is not unreasonable to infer that the virulence of the poison induces such disorganization or alteration in the constitution of the blood as to cause an arrest in those tissue-interchanges which belong to healthy nutrition. But, in truth, nothing definite is known on the subject. Mr. Savory and others believe that the disease may arrive without any previous traumatic history (*idiopathic pyæmia*, as it has been called); but that is entirely at variance with my own observation.

PREDISPOSING CAUSES of complicated traumatic infective fever are numerous. Among these may be mentioned severe shock, excessive loss of blood, imperfect drainage of a wound, disease of the kidneys, and imperfectly ventilated or overcrowded apartments, especially where the occupants are suffering from open wounds. Persons who receive an injury during convalescence from some exhausting malady, or who are suffering from erysipelas or gangrene, are vulnerable subjects for the disease; and the same is true of women during the puerperal state. Operations or injuries which open the cancellated tissue of bones leave the patient greatly exposed to the risks of pyæmia.

SYMPTOMS.—The development of this disease is sometimes foreshadowed by local changes. A suppurating wound which may have been progressing favorably suddenly becomes dry, glazed, and inflamed; or it may discharge a vitiated pus, the surrounding parts being swollen, œdematous, and often so painful as to cause great suffering on the slightest movement. This condition rarely occurs earlier than the eighth or twelfth day after the reception of the injury. In other instances the signs of the constitutional infection are manifested without anything peculiar or unusual being observed about the wound. The patient becomes despondent, lapsing into a drowsy, stupid condition. The skin is sometimes hot and dry, the mouth parched, the tongue hard and crisp, the urinary secretions greatly diminished in quantity, and often the stools are frequent, watery, and offensive. The fever which accompanies the above symptoms is markedly persistent, though the temperature may not rise very much above the normal standard. So long as secondary deposits or abscesses do not form, it is possible that the invasion of the febrile phenomena may neither be preceded nor followed by well-marked chills, except when an erysipelatous blush makes its appearance. Then a rigor will invariably occur with an elevated temperature. As the disease advances, the pulse becomes more feeble and frequent; the skin presents a dirty, pale, sallow color, with an icterode hue of the conjunctiva; the body emaciates; the temperature falls; and the patient dies in a state of collapse. Cases of this kind may run a fatal course in seven or eight days, or they may linger for two or three weeks; and in rare instances the patient may finally recover.

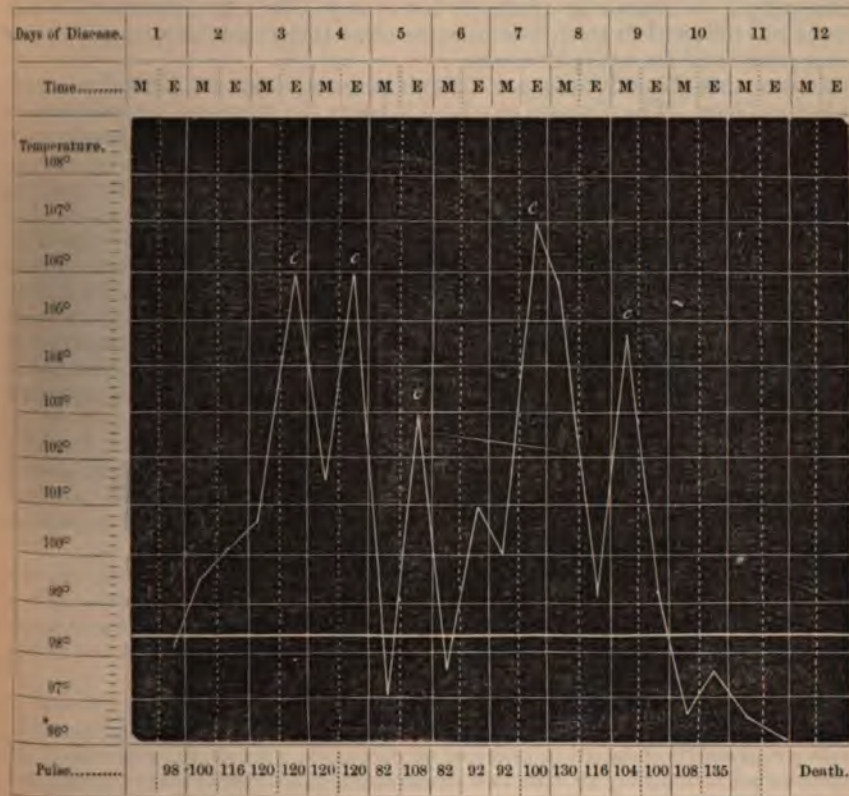
In Fig. 1233 there are recorded the thermometry, circulation, and respiration of a patient who presented the symptoms of septicæmia following a severe injury of the hand and arm, attended with diffuse suppuration, and who finally recovered. The diurnal variations of temperature, and its influence on the action of the heart and on the respiration, are well shown; also the steady decline of bodily heat coincident with defervescence and convalescence.

In other cases, the earliest recognized symptom is a chill or rigor, preceded and followed by a sudden elevation of temperature,—the thermometer rising in some instances, during the fever stage, as high as 104°

constipation; and not unfrequently the patient is harassed with nausea and vomiting.

The fatal tendency of the case is still further indicated by the increasing

FIG. 1234.



Fever chart in a case of pyæmia.

debility, the emaciation, the ominous flush on the cheek, the dusky or jaundiced color of the face, and the sordes which adheres to the teeth and lips.

The nervous system partakes of the general decay of the body, as exhibited in tremulousness, subsultus tendinum, stupor, or muttering delirium.

In some instances a hay-like odor can be detected on the breath of the patient, noticed by Bérard and Gamgee. I remember one case of the disease—following an operation for stone—in which this peculiar odor was so distinct that I called the attention of the medical attendant to its presence before entering the room of the patient.

When secondary deposits occur, the fact is often announced by painful swelling of the knee, ankle, or other joints, or by the rational signs of pneumonia, as cough, severe pain, and bloody sputa. The pulmonary implication may sometimes be detected by the presence of the physical signs peculiar to lobular pneumonia. Still, the lung may contain innumerable congestive and suppurating foci without furnishing any evidence, rational or physical, of such lesions. The occurrence of pleurisy or pleuritic effusion may be regarded as significant of multiple abscesses in the lung, as generally such conditions are secondary to the pulmonary complication.

The signs of secondary deposits in the liver are usually matters only of inference, founded on the frequency of their occurrence in this malady. But

undue sensibility to pressure or percussion over the right hypochondriac region will afford strong evidence that this organ has been invaded.

Early cerebral symptoms, as delirium followed by stupor, are grounds for predicating the existence of secondary deposits in the brain.

The period at which death takes place varies very much in different cases. Generally it is about the ninth or tenth day. In some instances the fatal event has followed in twenty-four hours after the attack, and in a few it has been postponed six or eight weeks.

DIAGNOSIS.—Usually it is not difficult to recognize complicated traumatic infective fever. The diseases to which it bears the strongest resemblance are ordinary or primary abscess, erysipelas, simple surgical fever, hectic fever, pneumonia, intermittent fever, and rheumatism.

Primary abscess.—It is no uncommon event, after an operation, for a patient, at some period during the after-treatment, to have a slight chill, followed by an elevated temperature and some fever. Such phenomena are always calculated to create alarm. But if, on examination, a tender point is discovered in the subcutaneous cellular tissue of some part of the body, with fluctuation, the symptoms may very confidently be referred to this superficial abscess; for the purulent formations attending infective fever do not primarily elect the subcutaneous tissue for their locations, nor is there a disposition in primary abscess either for the chills to repeat themselves or for a continuance of the fever.

Erysipelas.—A very small patch of erysipelatous inflammation, occurring in the course of a surgical case, will be sufficient to create a rigor, followed by considerable vascular excitement. The presence of the characteristic blush, unattended with a repetition of the chills, will explain the disturbance as being, in all probability, independent of pyæmia.

Simple surgical fever, sometimes called "*inflammatory fever*," is that constitutional disturbance which arises a short time after an operation, and which is the result of a slight blood-infection, but vanishes usually as soon as suppuration is established in the wound. It is by this latter circumstance that its true nature is recognized.

Hectic fever bears a very strong resemblance in many respects to complicated traumatic infective fever. In both there are chills, fever, and sweating, with progressive emaciation and loss of strength. A careful analysis of the phenomena belonging to the two diseases reveals several points which may serve to establish the distinction.

In complicated traumatic infective fever the chill is sudden and often very severe, the temperature very high, the fever intense, and the sweating profuse; in hectic fever the chill, when present, is slight, the temperature only slightly elevated, the fever moderate and more of a continuous type, and the sweating by no means profuse.

Hectic fever, moreover, is the product of a long-continued suppuration, and does not so rapidly exhaust the strength as the traumatic infective disease. Hectic fever has no tendency to produce secondary deposits in internal organs, though in subjects in whom there previously existed a strong constitutional proclivity to pulmonary disease suppuration may be developed in the lungs and even in other organs. This, however, is not due to the transposition of anything generated in a wound, but to inflammatory changes incident to constitutional weakness.

Pneumonia, primary or idiopathic, which is sometimes developed in the progress of a surgical case, and which, commencing with a chill, followed by fever, cough, and hurried respiration, resembles in these features that produced by infection, may nevertheless be referred to its proper source. This is done by considering that the announcing chill does not, as a rule, recur, and that the physical signs belonging to idiopathic pneumonia (such as dullness on percussion, the crepitating and subcrepitant râles, with bronchial respiration) are much more pronounced than in the infective pneumonia.

Intermittent fever.—Persons who have been exposed in miasmatic districts

often carry about with them the seeds of an intermittent, which may remain dormant for a long time, but are frequently called into activity by the shock attending a surgical operation. As a paroxysm of this fever consists in a chill followed by fever and sweating, and as these paroxysms are repeated, the resemblance to traumatic infective fever is very striking. There are, however, these points of difference. In intermittent fever the chill is generally of longer duration, and the temperature is rarely so high. The completeness, also, of the intermission, and the tendency to recur with great regularity as to time, will serve to distinguish it from complicated traumatic infective fever.

Rheumatism, especially that form which involves the articulations, has been confounded with complicated traumatic infective fever. Except as a result of infection, swellings of the joints do not commonly follow operations.

In rheumatic arthritis the articular effusion is usually serous and synovial, while from infection it is purulent. The signs on palpation will, consequently, be somewhat different. If the distinction cannot be appreciated by tact, the quality of the articular contents may be determined by the use of the aspirating needle.

There are two features belonging to complicated traumatic infective fever which will serve to distinguish it not only from ordinary intermittents, but also from all the other affections with which it has been compared. These are the height as well as the ever-shifting degree of temperature present, and the rapidity with which it destroys the strength of its victims.

Prognosis.—Recovery from complicated traumatic infective fever must be a matter of exceedingly rare occurrence. I can recall only a single case of the kind: so pronounced were all the symptoms of the disease that it is impossible for me to believe that an error of diagnosis had been committed.

An analysis of 29,434 surgical cases admitted into Guy's Hospital, London, during ten years, shows a mortality of 1749; and of this number 203 were from pyæmia, or 1 in 9 cases.*

When recovery does take place, it will be in that form of the disease in which secondary deposits in the internal organs are not present.

TREATMENT.—Hopeless though the disease appears to be when once established in the system, it is in the power of the surgeon to do much by the use of the proper prophylactic measures to prevent its occurrence; and foremost among these is ventilation. Previous to the introduction of forced ventilation, by means of the fan, into the Pennsylvania Hospital, traumatic infection was very common in the surgical wards of that institution. Since the adoption of this plan, now five years, not a single case has occurred. So very remarkable has been the change in this respect that it gives great importance to atmospheric dust, or to the septic matter which it carries, as a source of blood-poisoning. Not only, however, is it necessary to have a constant renewal of fresh air in a room or a ward devoted to the reception of surgical patients, but the utmost cleanliness must be enforced in regard to the instruments, the dressings, and the *personnel* of both physician and nurses. Everything employed about a wound should be thoroughly disinfected by the use of some preparation of carbolic acid or of permanganate of potash.

The beds and bed-clothing should be frequently changed, aired, and exposed to a full sunlight, and the dejections of the sick should be promptly disinfected and removed.

In hospitals, as well as in private houses, the drainage must be rigidly examined, and if any defects exist they should be immediately remedied. Many of the "modern conveniences" which have been introduced into private dwellings, such as permanent washstands and water-closets, in view of the fact that no perfect trap has yet been devised to exclude sewer gas, are well calculated to contaminate the air of sleeping-apartments, and, I doubt not, are fruitful sources of erysipelas, diphtheria, and typhoid fever, and render such apartments quite unsafe for surgical patients.

* Bryant's Surgery, p. 40.

Too much care cannot be observed in the dressing of wounds. No clots should be allowed to remain. These undergo dangerous putrefactive changes, the products of which, entering the vessels, may cause serious poisoning. Of still greater importance is the matter of drainage, by which the results of tissue-metamorphosis and other accumulations are conducted away from the wound.

Various internal remedies have been commended as possessing preventive properties, such as the hyposulphites, carbolic acid, permanganate of potash, chlorine water, alcohol, etc.; but their value as prophylactics has never been established to the satisfaction of the profession.

When the disease has been once established in the system, drugs possess little, if any, value as curative agents. They may serve to retard the fatal event, but never to prevent it. Quinine or cinchonidia, given in doses of ten to twenty grains daily, will modify the suppurative chills, reduce the temperature, and sustain somewhat the strength of the patient. The enormous doses of this drug given by Socin possess no special advantage in controlling the disease. Preparations of iron will also prove useful; and of these none are superior to the tincture of the sesquichloride, unless in cases wherein diarrhoea is excessive, when the liquor ferri pernitratis may be advantageously substituted.

Opium can also be given with good effect in cases of restlessness and sleeplessness, or of pain or looseness of the bowels.

If to these remedies be added a moderate amount of alcoholic stimulants, and the free use of milk and animal broths, we have embraced that plan of treatment which, in my experience, seems to contribute most to the comfort of the patient.

Various other remedies have been recommended,—as aconite by Textor, ergotin by Labat, veratria, and other medicinal articles; but experience has proven them to be inert as curative agents.

CHAPTER XXII.

FURUNCULUS, PHLEGMON, OR BOIL.

FURUNCULUS, from the Latin word *furo*, to "rage," is a circumscribed inflammation of the skin and cellular tissue, terminating in suppuration and the formation of a small central slough called the "core." It is an exceedingly common affection, and more generally met with in the young than in the adult and those advanced in life.

Males and females are alike subject to furuncular inflammation. Boils may occur singly or in numbers; and, while no part of the body is exempt, there are localities where they most frequently appear, as the face, back of the neck, posterior part of the trunk, nates, shoulder, axilla, perineum, and thighs.

There are two varieties of furuncle,—the *complete* and the *incomplete* or "blood boil," in popular phrase. In the latter the inflammation is less acute, and does not tend to suppuration.

Boils are met with in two very diverse and opposite conditions of the system, namely, in the strong and plethoric, and in the feeble or those who suffer from a disordered state of the digestion. Not unfrequently they appear during convalescence from a low form of fever. Exposure to a vitiated atmosphere is no uncommon predisposing cause, and hence the occurrence of such inflammation in the persons of hospital internes and in medical students much engaged in the duties of the dissecting-room.

Children during dentition not unfrequently suffer from furuncle, as do young females subject to disturbances of the menstrual function. The irritation produced by a blister, or by the protracted use of poultices, especially when the latter have been allowed to become sour, is frequently followed by one or more imperfect or "blood boils."

They are often associated with a diseased state of the kidneys, or with saccharine urine,—facts which should always suggest the necessity, in obstinate cases, or in multiple boils, of instituting a careful inquiry into the condition of the internal organs. Many persons during a temporary sojourn at the sea-side are afflicted with furuncle, particularly those who indulge in surf-bathing. The intense heat of summer also has no small influence in causing their appearance.

Not unfrequently the inflammation of furuncle originates around a hair or a sebaceous follicle, excited in the latter perhaps by some obstruction in the excretory duct of the gland. This is particularly true in those cases of the disease which appear in obese persons who are gross feeders.

There may also be a furuncular diathesis, which will explain those cases in which persons suffer from frequent attacks of boils, and, more rarely, those in which large numbers appear simultaneously over different parts of the body. I once had under my care a gentleman who was greatly addicted to the pleasures of the table, whose entire body, save the palms of the hands and the soles of the feet (parts generally exempt), was covered with boils, from the effects of which he finally sank and died. Boils vary in size from that of a grain of shot to that of a pigeon's egg.

SYMPTOMS.—The formation of a furuncle is announced by the appearance of a fiery-red, painful pimple, which gradually increases into a hard, conical mass, the surface of which gradually becomes purple or violet colored. The pain at first is of a burning and smarting nature, but afterwards becomes throb-

bing. The glands in nearest relation to the boil are tender and swollen, and the muscles underneath the inflamed point stiff and sore. Every movement of the part provokes more or less pain, compelling the patient to maintain a fixed and mechanical attitude. Finally, a small vesicle rises on the summit of the conical mass, the induration begins to soften, and fluctuation can be distinguished,—signs betokening the existence of suppuration.

Usually it requires from six to eight days for the furuncle to mature. It is only where the boil is quite large, or where a number of boils are simultaneously present, that the general system sympathizes with the local disorder. Under such circumstances the patient may experience chilly sensations, even a rigor, followed by the loss of appetite, a coated tongue, headache, and some febrile excitement.

The anatomical appearances presented by a furuncle in its incipency cannot be exactly determined, as the opportunity for examination does not occur; but, from the regions selected by the disease, those in which the sebaceous glands most abound, and from the pain and the very limited and angry point of redness which characterize its early stage, the inflammation would appear to have its origin in the vascular net-work belonging to a sebaceous gland. When the swelling is laid open, we find a mass of dead connective tissue, interpenetrated by consistent yellow pus, or by pus and blood. It is this necrosed cellular tissue which constitutes the core of the boil, and which has perished by the intensity of the inflammatory transudation. Occasionally the entire contents appear to be little else than blood, in which case the disease is called a "blood boil." The indurated circumference consists of a plastic infiltration of the surrounding areolar tissue, with increased vascularization, which, as in acute abscess, appears to be reared as a wall of limitation against the intrusion of the inflamed products into the adjacent tissue.

TREATMENT.—In the very commencement of the inflammation it is possible to cause the furuncle to abort. For this purpose a little blistering collodion, the strong mercurial ointment, tincture of iodine, ice, bichloride of mercury, and several other agents have been applied over the affected part. The most promising agent for this purpose, however, is a mixture of carbolic acid and glycerin, consisting of equal parts. A single drop worked into the summit of the boil with an ordinary quill toothpick will often effect its resolution. I doubt, however, if anything is gained by the abortive plan, even when successful. The popular notion in regard to all such affections, that they are outlets for certain peccant matters or humors, and therefore possess, according to the vulgar opinion, some value, though it need not be expressed in money, is not without plausibility; and I therefore prefer to accelerate the suppuration by hot poultices of flaxseed-meal or by compresses of hot water, and, as soon as the swelling is sufficiently soft, to lay it open with a delicate, sharp-pointed bistoury, discharge the pus, and squeeze out or pick out the core with a pair of forceps. After this is done, a warm wet compress or a pledget covered with lead cerate, and a bandage bringing the sides of the cavity together, will soon complete the cure.

When boils appear in numbers or follow one another in rapid succession, indicating a furuncular diathesis, general remedies are employed to correct the evil. Arsenic, iodine, mercury, liquor potassæ, yeast, and other articles have been commended as possessing peculiar efficiency in arresting the disease. But I know of no specific for such a state. The vice can be corrected only by treatment based on general principles. If the patient is a person of a full, plethoric habit, overfed and over-stimulated, a mercurial purgative, followed from time to time by a saline laxative, with the use of an alkali, such as the bicarbonate of potash, constitutes the most rational plan of treatment. In sickly, exhausted persons, with bad hygienic surroundings, an opposite course must be pursued. Iron, quinine, mineral acids, red wine, a nutritious diet, and fresh air are indispensable requisites. Medical students and hospital internes who suffer from boils should at once detach themselves from

their accustomed duties and go into the country until their constitutional forces have been recovered. To linger longer in a vitiated atmosphere is to invite an attack of typhoid fever, or to endanger their lives by the risk of a poisoned wound.

Anthrax, or Carbuncle.

Anthrax, like furuncle, is the result of a cutaneo-cellular inflammation followed by suppuration and sloughing, the chief differences between the two being the intensity of the process, its greater tendency to spread, and the presence of multiple openings which exist in carbuncle. Indeed, anthrax may, without committing the least anatomical violence, be defined as a collection of boils, each opening on its surface and answering to one member of the group.

Carbuncles differ in size, varying from one inch to six inches in diameter. In an old man who was under my care, in the surgical department of the Philadelphia Hospital, for anthrax, the anterior part of the chest was involved to an extent which would have been barely covered by a large dinner-plate, and yet, notwithstanding the great exhaustion, the patient struggled successfully through the disease.

Carbuncles commonly select for their site those portions of the body on which integument is thick and dense: thus, they are met with on the back of the neck and the trunk, on the scalp, over the nates, occasionally on the thigh, and upon the chin, and less frequently on the side of the face near the nose. In the last two localities the presence of carbuncle is always attended with danger.

Anthrax is seldom witnessed in persons before mature life, and generally appears after the age of fifty.

CAUSES.—The causes of carbuncle are of a general rather than a local nature. The disease is never seen in persons enjoying sound health. Those who lead an indolent or sedentary life, and who indulge in the pleasures of the table, are peculiarly prone to suffer from its attacks. In such the digestive organs are overtaxed, and from habits of inactivity the products of tissue metamorphosis are not eliminated as they should be by those important emunctories, the glands of the skin and the kidneys; consequently, by their retention or new chemical combinations, the blood is loaded with poisonous materials, which, in the process of discharge through the emunctories of the skin, kindle local inflammation. Those, again, whose constitutions have been damaged by intemperance, deprivation, and vicious indulgences are proper subjects for carbuncle. Diabetes mellitus and albuminuria are also conditions strongly predisposing to carbuncle. The season of the year appears to have some influence in producing carbuncular inflammation, as most cases occur during winter and spring months, possibly on account of the effects of cold, sudden changes of temperature, and the in-door life which many persons lead,—causes which tend to disturb the functions of the skin. Males are more frequently attacked than females.

SYMPTOMS.—The earliest sign of carbuncle is the appearance of a small, red, pointed pimple, accompanied by an itching, burning, or smarting pain, the peculiar severity of which would seem to be entirely disproportioned to the size of the vesicle. The base of the pimple enlarges in its circumference equally on all sides, is hard, brawny, and at first but slightly raised above the level of the surrounding skin, which presents a dusky-red appearance. As the swelling increases, it assumes more of a conical or mound-like shape, the color becoming more purple or livid, and the pain having a throbbing character. In addition to these appearances, there is experienced a feeling of extreme tension. All the muscles in the neighborhood become sore and rigid, and the lymphatic glands in the vicinity tender and enlarged. It is usually at this stage that small vesicles begin to form, each one becoming a little slough, and, after being broken, leaving a number of openings over the surface of the swelling, giving to the carbuncle a cribriform appearance, and exposing at

the bottom of each opening a gray slough of cellular tissue. These openings enlarge irregularly. Through them discharges a thin, irritating, ichorous fluid, derived from the decomposing connective tissue below.

In bad cases, constitutional symptoms of an asthenic type appear very early in the course of the inflammation, not uncommonly ushered in by a chill, followed by fever. The tongue becomes dry and brown; the taste is perverted, and the appetite lost; the complexion becomes sallow; the urine is diminished, and along with a frequent feeble pulse there is a rapid loss of strength. There is a form of carbuncle which is occasionally seen on the lips or faces of young persons, exhibiting a remarkable tendency to spread. It is attended with much swelling and alteration of the features, rapidly precipitating the system into a low, typhoid condition, and, unfortunately, little amenable to treatment. Though the inflammation is carbunculous, it certainly depends on causes differing from those producing ordinary anthrax, as it exhibits no tendency to limitation, and but little to suppuration or ulceration. The fatal termination seems to be due to extension of the inflammation along the veins or lymphatics to the brain, or to pyæmic changes in the blood.

DIAGNOSIS.—Carbuncle can be scarcely confounded with any other affection. Its extreme diffused hardness and violent burning and itching pain, its multiple openings, its slow progress, and the accompanying constitutional disturbance, are sufficiently distinctive to prevent its being confounded with furuncle.

PROGNOSIS.—Unless the carbuncle is unusually extensive or is multiple, and the patient aged and exhausted, recovery generally takes place. When the disease begins on the scalp or the face, or extends from the neck to the head, the patient being old and infirm, life is in great jeopardy. If complicated with diseased kidneys or with saccharine urine, the progress of the disease will be towards a fatal termination.

Anatomical structure.—Upon making a section of a carbuncle, especially near its circumference, the density of its substance, in consequence of the compact infiltration, is so great that the sensation communicated through the knife is not unlike that produced by cutting into a fibroid tumor. Each opening on the surface of the swelling marks the position of a former slough of the skin. In the interior there lies a slough of connective tissue, resembling in appearance and color a mass of wet felt, and bathed in a thick, purulent fluid. At the circumference of the swelling the same plastic infiltration of areolar tissue and the same vascularization as in furuncle exist.

TREATMENT.—The treatment of carbuncle is very simple. The indications are to arrest the extension of the inflammation, to expose and remove the slough as quickly as possible, and to sustain the powers of life while this process and the subsequent closure of the ulcer are being accomplished. To arrest the extension of the carbunculous inflammation and to expose and remove the disorganized connective tissue, four different plans have been pursued. The first plan, with a few exceptions, is the one to which I am partial. It is carried out most satisfactorily by preparing a flaxseed-meal poultice, sprinkling over its centre a little coarsely-powdered crude soda, and covering it with a piece of tarlatan upon which has been spread a layer of compound resin ointment. This is to be applied to the carbuncle as warm as can be borne, and, in order that the heat and moisture may be retained, it should be covered with a piece of oiled silk. Some add a little yeast to the poultice; but I have seen no special advantage following its use.

This dressing requires to be renewed every six hours. The effect of the heat and moisture is to hasten suppuration and to relieve tension and pain, by softening the tissues and thereby diminishing the pressure on the nerves of the inflamed part. The alkali, by its caustic properties, facilitates the formation of little sloughs of skin which naturally occur. As soon as these sloughs drop out from the surface of the carbuncle, the soda may be withdrawn, and the poultice, with its stimulating ointment, continued. The

openings rapidly enlarge and run into one another, until, in a short time, a kind of crater is formed, which exposes the dead cellular tissue below.

As the sloughs loosen they are to be picked away with the forceps. In doing this it will sometimes be necessary to sever their surrounding connections with the scissors, always observing to keep within the limits of the dead tissue, so as to avoid hemorrhage.

After detaching such portions as admit of being readily removed, the surface of the ulcer is to be washed free from all the discharges by injecting, through the remaining portions of the slough, a solution of permanganate of potash, after which the poultice with the resin ointment is again to be applied.

This procedure should be repeated morning and evening until all the dead tissue is removed, when the ulcer will rapidly be filled up by granulations. During this process and that of cicatrization the resin cerate is all the dressing that is necessary.

When a large carbuncle has been once cleared of its necrosed areolar tissue the remaining opening presents an appearance of great depth. This, however, is only in appearance, being due to marginal thickening, which is slow to disappear. The cavity of a carbuncle very seldom transcends the limits of the deep fascia or the sheaths of the muscles. It is also worthy of observation that, notwithstanding the great loss of substance occurring in carbuncle, deformity from cicatricial contraction is rarely met with. This is very strikingly exemplified after carbuncles on the back of the neck.

Vesication.—When the carbunculous inflammation exhibits a tendency to spread, the tumor rising only slightly above the surface, the extension of the disease may be very decidedly arrested by the application of a blister large enough to extend half an inch beyond the limits of induration. The free discharge of serum appears to moderate the intensity of the inflammation and the profuse infiltration, both of which are hostile to that circumferential wall of lymph which arrests the progress of the disease. When the carbuncle has been brought to a halt, the treatment by poultices becomes proper.

Incision.—At one time, following in the wake of surgical practice, I was in the habit of making the traditional crucial incisions in all cases of carbuncle. (Fig. 1235.) One day I was called to see two patients very much alike in constitution and habits of living, and each suffering from a large carbuncle. In one case I incised freely, as a preliminary part of the treatment; in the other I employed heat and moisture. Both patients recovered at the same time. Since then eighteen years have passed, and I have rarely incised a carbuncle, though very many cases of the disease have been under my care. The operation, as a rule, neither hastens the cure nor lessens the suffering.

The only form of carbuncle in which the use of the knife is demanded is that on the face or lip, which should be cut the moment the inflammation manifests a tendency to diffusion. When too profuse a hemorrhage follows the incision of a carbuncle, the wounds should be filled with rolls of lint soaked in hot

FIG. 1235.



Crucial incision of carbuncle.

alum-water, and a compress and bandage applied for a few hours. When the painful sense of tension and throbbing cannot be relieved by moderate doses of anodynes, I would not interdict incision.

Cauterization is applied in two ways: first, by caustic potassa applied to the surface of the carbuncle, as a substitute for cutting; and, secondly, by the same agent being rubbed into the incision,—a twofold barbarism.

Besides the methods already described there has been advocated subcutaneous incision by Mr. French, in which a tenotome is introduced into the carbuncle at three or four points, and its cellular tissue divided in different directions before withdrawing the instrument. Pressure has also been favorably spoken of by Dr. O'Ferrall; but, after no small experience in this kind of surgery, I can say that these plans of treatment possess no special merit whatever.

Constitutional treatment.—The constitutional treatment of carbuncle should not be overlooked. The system, throughout the entire progress of the disease, requires the most generous support. The state of the intestinal secretions should be inquired into; and if it requires correction, a gentle cathartic, preceded by a little calomel or blue mass, may be given, after which the muriated tincture of iron and quinine constitute the most valuable tonics. Opium in some form, to relieve pain and restlessness, is indispensable. Milk, animal broths, and eggs must supplement any deficiency in the amount of solid food which the patient is able to take; milk-punch and wine may be freely given.

A person who has successfully passed through a long carbuncular attack will generally be left in a weak and depressed state for some time. A change to the seaside or the mountains will aid in restoring the wonted constitutional vigor and health, provided the season of the year is favorable.

Erysipelas.

Erysipelas is one of those acute inflammatory febrile affections which in many instances complicate surgical diseases. Its presence is always a source of great anxiety to the surgeon. It may be either idiopathic or traumatic, and may appear in either a sporadic or an epidemic form. It is both *infectious* and *contagious*. It is the traumatic form of the disease which possesses the greatest interest to the surgeon. The varieties of erysipelas may be divided anatomically according to the particular tissue-plane involved. Thus, we have the *cutaneous*, the *cutaneo-areolar*, and the *areolar*. The inflammation, however, is not limited to these structures. It may extend below the deep fascia, implicating the intermuscular connective tissue, the muscles, the periosteum, and the bones. The membranes lining both open and closed cavities, as the mucous and serous, the blood-vessels, and the lymphatics, are also the subjects of this affection. Any portion of the body may be invaded by erysipelas. The face and the scalp suffer most in what is termed the idiopathic form of the disease; in the traumatic variety the lower extremities are affected oftener than the upper.

CAUSES.—The causes of erysipelas are *predisposing* and *exciting*.

PREDISPOSING CAUSES.—Among these may be mentioned intemperance, gluttony, obesity, diabetes, disease of the kidneys, exhaustion from loss of blood, disorders of the liver and of the digestive organs, and bad hygienic surroundings, such as overcrowding of wounded patients, imperfect ventilation, and defective drainage.

The puerperal state.—The relation between erysipelas and puerperal peritonitis has long been observed. The uterus at this period is particularly vulnerable, and the most lamentable loss of life has occurred from accoucheurs attending at the same time cases of erysipelas and women in labor. At one time in Lancaster County, Pennsylvania, a fatal puerperal peritonitis prevailed, which carried off a large number of parturient women. This fatality occurred chiefly in the practice of a gentleman who had under his care cases

of erysipelas, and who was at first skeptical as to the communicability of the disease through personal contact. The epidemic ceased only when he withdrew for a time from obstetrical duties and supplied a substitute. No period of life is exempt from erysipelatous inflammation; but the largest number of cases are met with in persons over fifty years of age. Males and females are alike liable to the disease; but the former suffer more frequently, simply because their occupations expose them more to those accidents which play so important a part in originating the inflammation.

Season of the year.—On this point there is some difference of opinion. In this country and in England the largest number of cases of erysipelas develop during the months of January and February. In Vienna the disease, during a decade, was most common in the spring and fall months; and in Berlin, during the winter and spring.

Dampness.—Wet weather exercises no small determining influence in the production of erysipelas. Indeed, the presence of the disease during a cold or warm *dry* state of the atmosphere is by no means common.

Hereditary influences must also be recognized among the conditions predisposing to the disease. There are many instances of parents transmitting this tendency to their children.

Other constitutional peculiarities are sometimes met with, such as when the disease appears periodically three or four times a year in the same person.

Exciting Causes are wounds and contagion. Any wound, whether incised, lacerated, punctured, poisoned, or gunshot, may develop the disease. Those injuries in which the tissues are bruised or torn, or which were received under circumstances tending to confine the inflammatory products of the injury, are most favorable for inducing an attack of erysipelas. Hence the frequency of this inflammation after crushes of the limb or after punctured wounds. In such cases the immediate irritant is no doubt in the products of devitalized tissue, provoking an inflammation in the contiguous lymph-vessels. In the vast majority of cases of erysipelas, a wound, however trivial, is a necessary complement to the existence of the disease, which would rarely appear without it.

There are peculiar states of the general system, or of the atmosphere, when the slightest scratch of the skin, even the bite of an insect, is followed by an erysipelatous attack. This personal liability is not always limited to the narrow compass of a hospital ward or a private dwelling, but may affect districts several miles in extent. It is during such periods that persons suffering from bone-disease attended with fistulous openings, or from unhealed wounds or chronic ulcers, often have attacks of erysipelas, commencing in their open sores; and at such times a prudent surgeon will decline all cutting operations other than those of absolute necessity.

Infection.—The infectious nature of erysipelas is predicated on several considerations. Many persons suffer from the disease in consequence of receiving a slight scratch while making an autopsy. Foul sponges, soiled dressings, even the hands and clothing of a careless nurse, are sufficient to communicate some peculiar *materies morbi* to a wound which is capable of developing this form of inflammation. Orth,* in a series of twenty experiments, succeeded in communicating erysipelas to the lower animals from man, by introducing beneath the skin the serum obtained from the flaps and the subcutaneous tissue of a part affected with the disease; and Doepp gives the history of nine children who were inoculated from a scab taken from a child in whom the vaccine lymph had produced an attack of erysipelas. They all had an attack of the disease. For five years not a case of erysipelas developed in the surgical wards of the Pennsylvania Hospital; but not long afterwards, during the cleansing of the walls of these same wards, quite a number of cases suddenly made their appearance.

Contagion.—Although the theory is questioned by some, there are cogent reasons for believing that erysipelas is due to a pathogenic microbe; indeed,

* Schmidt's Jahrbuch, xxx. p. 184.

inoculations made from cultures of the streptococcus have been found to produce the disease. Thus can we explain the simultaneous appearance of the disease in the different wards of a dirty hospital, or the fact of a number of persons in the same ward or room being attacked at the same time through germ-laden dust. Of this there are numerous examples.

Volkman* furnishes a curious history of an eruption of erysipelas which strongly corroborates the contagion theory. The disease commenced in a ward containing thirteen beds, arranged in two rows on opposite sides of the apartment, and passed from bed to bed, affecting all the patients on one side, then returned in the same regular manner on the opposite side, until twelve out of the thirteen patients were attacked.

Cutaneous Variety.—This form of the disease is sometimes regarded as an erythema; but I do not admit the identity of the two inflammations. On the contrary, I regard them as entirely distinct. Erythema never tends to implicate the subcutaneous cellular tissue, is not communicable, does not vesicate, and never follows a wound,—peculiarities which pertain to erysipelas. Neither does erysipelas recede and then reappear in the *same place*, as it is common for erythema to do.

SYMPTOMS.—*Cutaneous erysipelas* may appear without any noticeable constitutional disturbance, the first indication of the disease being the appearance of an intensely red or scarlet blush, with tension of the surface, situated, when it is of a traumatic origin, at the margin of, or contiguous to, the wound. The attendant pain is of a pungent or burning character. The redness, instead of being sharply defined, usually blends insensibly with the color of the healthy skin, and is sometimes exchanged for a dusky hue. When pressed upon with the finger, the vessels of the inflamed surface are temporarily emptied, leaving the part white, but only for a moment, as the blood instantaneously returns to the capillaries. There is very slight transudation, and consequently but little, if any, swelling. In two or three days the redness disappears and is followed by desquamation. Not unfrequently, after leaving one part it will appear in another, constituting the *erratic* or wandering form of the affection, answering to the fourth species of Willan.

In the more serious forms of this variety of erysipelas, the cuticle is raised into blebs or vesicles containing a semi-transparent serum, which soon becomes turbid. The inflammation, especially in the idiopathic variety of the disease, may rapidly extend over the contiguous portion of a limb or the trunk, or, if on the face, to the ears, the eyelids, and the scalp. The lymphatic glands become slightly enlarged. The eyelids are swollen, tense, and closed, and the face is so entirely disfigured and altered in its appearance by the swelling that it is often impossible to recognize a single natural feature of the countenance; there is also very great tenderness. In two instances of cutaneous erysipelas, both following operations (the one after an excision of the mammary gland, the other after the removal of a sebaceous cyst of the scalp), the inflammation in the first case spread from the breast upward and downward, until the entire body was involved; and in the last case, beginning on the head, it gradually descended and disappeared at the toes.

When the erysipelas arises from a traumatic cause there is often noticed an alteration in the wound, the discharges from which entirely subside, or become bloody and serous instead of being purulent.

The constitutional symptoms which usher in an attack of this nature are nausea, headache, rigors, alternating with flushes of heat, accompanied with a dry tongue, hot skin, frequent pulse, and a high temperature, reaching not unfrequently 103° to 105°. These signs may antedate the local manifestations twenty-four or thirty hours, or they may appear coincidentally with them. The tendency of the fever is generally towards a low or typhoid form; and when the inflammation spreads over the face and scalp it is usually at-

* Ziemssen's Cyclopædia, vol. ii. p. 435.

tended with more or less mental wandering. In the last-named condition the disease may pass beyond the limits of the skin and invade the mucous membranes of the eye, nose, mouth, and fauces, extending even to the pharynx, larynx, and trachea. On the third or fourth day both the fever and the inflammation have, ordinarily, culminated, and from this period onward there is a gradual and concurrent subsidence of both the general and the local phenomena; the redness fades and changes to a yellow color, the swelling subsides, and the parts become more tolerant of pressure. The vesicles and blebs burst, allowing their contents to desiccate into yellowish scales, and sometimes into brown crusts, or the serum may be absorbed. In either event there is a free desquamation of furfuraceous scales, leaving the skin corrugated and stiff for many days after the disease has passed away.

If the scalp has been the seat of the affection, the hair falls; but, as the follicles are not destroyed, it is reproduced as abundantly as before the attack.

Cellulo-Cutaneous or Phlegmonous Variety.—As the name implies, this inflammation is not confined to the skin, but extends into the subcutaneous connective and adipose tissues. The attack is generally, as in the other variety, preceded by a rigor or chill, followed by a hot skin. These may be repeated several times before the local signs attract attention, and may be mistaken for the commencement of an ordinary intermittent. As compared with the cutaneous variety the swelling is greater, the induration harder and deeper, the color less red, having a dusky, dark, or mottled tint, according to the degree of embarrassment experienced by the venous circulation; the skin is glossy and shining, the pain more severe, perhaps throbbing, and the vesication or blebs, when present, somewhat larger. Oedema is also present. The inflammation exhibits a marked tendency to become diffuse by extending through the connective tissue, and finally, unless arrested, terminates in suppuration, which, not being circumscribed by any wall of lymph and showing no disposition to point, is liable to cause sad havoc with the superficial fascia. The formation of pus in the subcutaneous tissue is announced by the peculiar soft, boggy feel of the parts, and not unfrequently by a recurrence of rigors. In neglected cases the inflammation may pass beyond the boundary of the deep fascia, and the resulting suppuration occasion extensive disorganization of the muscles and other components of the part.

When the inflammatory transudation is very sudden and abundant, the subcutaneous cellular tissue may perish from the strangulation of its vessels and be discharged in the form of gray sloughs.

The constitutional symptoms accord with the local condition, the fever assumes more and more a typhoid character, there is much nervous irritability, with loss of strength; and, when the scalp is affected, delirium is usually present. If the disease tends to a fatal termination, the tongue, at first covered with a white, cheesy-looking coat, becomes dry and covered with patches or streaks of a yellow and finally a brown or black crust, between which the surface of the organ is red, dry, and glazed. The thirst increases; the appetite is gone; and the patient suffers from nausea and occasional vomiting. If the disease tends to a fatal termination, the sclerotica, conjunctiva, and face assume an icterode hue; bile appears in the urine; sordes collect about the gums; diarrhoea sets in; the pulse becomes frequent and feeble, and the patient sinks into a state of coma, which in a short time ends in death.

SUBCUTANEOUS ERYSIPELAS, sometimes called *diffuse cellulitis*, may exist without any inflammation or redness of the skin, and is, consequently, liable to progress for some time undetected. It does not always commence at a wound, but may first appear at some distance from the latter. It may arise from a compound fracture, or from a poisoned wound, as that resulting from the bite of a venomous snake or from a puncture received while making an examination of the dead body. It may be idiopathic. In one instance I witnessed the sloughing away of the entire subcutaneous cellular tissue of the

lower extremity from the ankle to the crest of the ilium. The patient was a man seventy years of age, and could only refer the disease to having taken cold while sleeping in a damp room. In aggravated cases of both cutaneous and facial erysipelas there is a tendency to suppurative inflammation in parts more or less remote from the original seat of the disease: thus, an opposite limb from the one affected, or one of the joints of the same limb, may be attacked. In like manner the mucous membrane of the fauces, pharynx, and larynx may suffer, and so also the serous membranes, as the pleura, the peritoneum, and the arachnoid. With regard to the last, the arachnitis which frequently follows erysipelas of the hairy scalp is doubtless merely an extension of the inflammation by blood-vessel continuity, as the vascular unity of the extra- and intra-cranial parts is well known. The same anatomical fact will explain the appearance of the disease in the fauces,—a peculiarly dangerous complication. Erysipelas of the fauces and pharynx is announced by the intensely red, glossy, swollen, and œdematous state of the fauces, pharynx, and tonsils, the latter, together with the half arches, becoming covered with patches of lymph, and imparting, through the vitiated secretions, a highly offensive odor, the inhalation of which is not unattended with danger to physicians and attendants. There is also more or less difficulty in swallowing. In some instances facial erysipelas is secondary to that of the throat.

ERYSIPELAS OF THE LARYNX.—When the inflammation travels beyond the boundaries of the fauces, the larynx is liable to suffer. The inflammatory transudation of the loose cellular tissue about the base of the epiglottis and the glottis produces an œdematous state of these parts, which is followed by difficult respiration and loss of voice, in some respects simulating croup. The extension of the disease to the lungs, causing pneumonia, though not common, does sometimes occur.

SYNOVIAL AND SEROUS MEMBRANES.—Where a joint, or the pleura, or the peritoneum is attacked, it is, in many cases at least, difficult to trace the relation between these complications and the primary erysipelas, except through the infection of the blood, in which case they stand related to the original disease in the same manner as the secondary accidents of complicated surgical fever do to a wound. I am aware that all connection between pyæmia and erysipelas is denied by some, and that facts are adduced in corroboration of this view. For example, it is stated that at the St. André Hospital, Bordeaux, in 1844, erysipelas was so prevalent that a blister or a leech could not be applied without the application being followed by an attack of the disease, and yet there were no cases of pyæmia. Again, at the military hospital at Trautemannau, in 1866, there were many cases of pyæmia, but no erysipelas; and in 1870, at the Berlin Military Hospital, Retzmann observed both erysipelas and pyæmia, but not at the same time. With no disposition to challenge the accuracy of these statements, I have the most incontrovertible reason—namely, the testimony of the post-mortem knife—for knowing that patients suffering from erysipelas do sometimes die from pyæmic infection.

Duration of the disease.—The duration of erysipelas varies very much in different cases. When seated on the head and face it is most obstinate, continuing, as a rule, from seven to fourteen days. On the trunk the disease rarely subsides in less than ten days; and when located on the upper or lower extremities it remains from eight to ten days. In exceptional cases, erysipelas may continue for six or eight weeks. Occasionally we meet with instances of *relapsing* erysipelas, in which, just as convalescence has apparently been well established, another eruption of the disease appears, and this may be repeated several successive times: under such circumstances the affection may be prolonged far beyond the usual period.

Explanation of the phenomena.—There are several peculiarities connected with this disease which will attract attention. Among these I will mention the manner in which the inflammation extends, in one place sending out long, tongue-shaped patches of redness, in another assuming a crescent form, and in another making a considerable détour to avoid a particular point, appearing

again on the opposite side. This behavior of the disease has an anatomical explanation. The interlacing of the connective-tissue bundles is arranged in such a manner that the interspaces, usually occupied by masses of fat, have an elongated form. It is on the circumference of these spaces that blood-vessels are distributed. The subcutaneous connective tissue is connected to the skin above, and to the deep fascia below, by numerous fibres, many of which have a perpendicular direction. The tension which results from the inflammatory infiltration compresses the vessels at some points more than at others. Into those whose channels are freest the blood is determined, and in the same direction the infiltration will spread, so that the redness and swelling move together. There are portions of the body in which the skin is held closely to the deep fascia by threads of connective tissue,—as over Poupart's ligament, at the linea alba, and below the nates. The same arrangement exists wherever there are furrows or wrinkles on the surface of the skin. These are localities in which the fascia refuses to yield, or yields very slowly, to transudations, and where, in consequence, the vessels must be subjected to strong pressure. Accordingly, we find that the redness of erysipelas will march directly up against one of these barriers, and either pass round at its extremities or linger a considerable time before surmounting the obstacle, after which its progress again becomes rapid. It will be found that on those portions of the body where the tension of the superficial fascia is uniform—as over the abdomen, the back, and the hairy scalp—erysipelatous inflammation will move in a regular and unbroken wave. The enlargement of the glands which so often accompanies severe attacks of erysipelas is an infective result, and due to an irritation caused by the presence of morbid products entering the nearest lymphatic vessels. The swelling and induration of the inflamed part are dependent on the infiltration of serum and lymph into the subcutaneous tissue. The pressure of the transudation on the skin nerves gives rise to the increased sensibility and pain experienced. The shining, glossy appearance of the skin is the result of stretching and desquamation, and the vesicles or blebs which appear on the cutaneous surface are elevations of the cuticle filled with serum. These vesicles frequently contain great numbers of bacteria. The boggy feel communicated to the touch in a case of deep or subcutaneous erysipelas is due to the formation of an unencircumscribed collection of pus lying in the midst of a mass of dead connective tissue, and the diminished sensibility which accompanies this condition is to be referred to the disorganization of the nerves which run through this tissue.

Post-mortem appearances.—These may be divided into three, found in the skin, in the subcutaneous tissue, and in the internal organs. The skin presents the appearance of an acute dermatitis. The corium and the underlying cellular tissue are swollen and are interpenetrated by granular leucocytes and by serum. The blood-vessels are distended and crowded with corpuscles, and, together with the superficial lymphatics, which are also filled with granular cells, are surrounded with these cell-forms, which crowd the tissue, and whose presence is due to proliferation and emigration. These appearances of the skin, according to the observations of Volkmann and others, are confined to the first three or four days of the disease; after which they disappear, leaving the skin very much as before the attack. The subcutaneous tissue will be found infiltrated with serum, lymph, and pus; the lymph presenting a light, creamy-like appearance, and the pus having a yellowish-green or reddish color. The connective tissue is changed into a gray or ash-colored slough, somewhat resembling wet tow. When the inflammation has passed beneath the deep fascia the muscles are seen separated from one another by the fibrinous and purulent products; and in some instances even the bones are laid bare, from the detachment of the periosteum. Hueter found in the fluids of the inflamed tissues numerous bacteria of different forms.

The signs of internal inflammation have been generally noted in fatal cases of the disease. Within the cranium the arachnoid is found with patches of

opacity; the vascularity of the pia mater is materially increased, and its connective tissue infiltrated by a sero-purulent fluid; and in the ventricles of the brain is a similar product. In the chest are seen analogous inflammatory results, the pleura being thickened and made adherent in some places by unhealthy lymph, its cavity containing a dirty serum and pus, intermingled with flakes of cheesy matter. In the abdomen, both the visceral and the parietal peritoneum exhibit like changes with those of the pleura. The spleen is swollen, and in the kidneys the evidences of a diffused nephritis are present.

DIAGNOSIS.—The recognition of erysipelas is not difficult. The intensely red and shining appearance of the skin, its hot, œdematous, sensitive, and swollen condition, and the elevated temperature and pronounced constitutional disturbance, are quite significant of the nature of the disease. The only affections with which erysipelas is liable to be confounded are erythema, phlebitis, angioleucitis, diphtheria, and quinsy. Erythema, however, is transitory, is not accompanied with pain, swelling, or vesication of the skin, is attended with very little, if any, alteration in the temperature, and is not followed by desquamation. In phlebitis, the redness, hardness, and tenderness are confined to the course of the affected vein, instead of being diffused, as in erysipelas. In inflammation of the lymphatics, the redness and morbid sensibility are also limited, being linear and confined to the course of those vessels. The greatest difficulty will be encountered in distinguishing erysipelas from diphtheria. In both there are redness, swelling, and exudation of the mucous membrane of the throat, and in both marked constitutional symptoms of an adynamic type. The distinction may be established by the nature of the prevailing epidemic, and by the great debility and the absence of paralysis of the palate in erysipelas. The nasal mucous membrane is also generally less involved in this disease. In quinsy, the swelling of the throat is greater and the constitutional symptoms are less severe than in erysipelas. The redness which accompanies nettle-rash and the poisonous action on the skin of certain plants, as the *Rhus toxicodendron*, may be mistaken for erysipelas; but the severe pricking pain of the first and the intense itching of the last, with the absence of chills and fever, would be sufficient to determine the true nature of the affection.

PROGNOSIS.—Although erysipelas is always a source of anxiety to the surgeon, the fatality of the disease is not very great. The circumstances which influence the death-rate are various, such as the habits and age of the patient, whether temperate or the reverse, young or in advanced life (being more unfavorable in children and old persons than in those of middle age); the character of the disease, the subcutaneous being more serious than the cutaneous form; the situation of the inflammation, erysipelas of the head, fauces, and larynx being always attended with danger; to which may be added the nature of the epidemic when generally prevailing, in some instances being very virulent and in others mild; and, lastly, locality,—the disease being usually worse in hospitals (especially when many wounded persons are crowded together) than in private life. If after five or six days the pulse continues to increase in frequency and the temperature to rise, there is ground for grave apprehension.

The estimated fatality, as computed by different writers, varies from 3 to 50 per cent. Taking all cases together, both medical and surgical, the mortality may be set down at about 12 per cent.,—an estimate based on an analysis of 700 cases. An examination of 212 cases of erysipelas occurring at St. Bartholomew's Hospital, London, during a period of eight years, and which have been arranged for me in tabular form by Dr. Baum, of this city, exhibits some points of interest in connection with this subject.

Cases of Erysipelas which developed in Surgical Wards and also after Operations at St. Bartholomew's Hospital.

	Male.	Fe- male.	DEATHS.		PER CENT.		Total.	Per Cent.	Year.
			Male.	Fe- male.	Male.	Female.			
Developed in wards.....	13	11	1	...	5.88	.....	33	3.03	1869
After operations.....	4	5	...	...	...	...	...	.....	.....
Developed in wards.....	12	6	4	2	23.52	21.42	31	22.58	1870
After operations.....	5	8	...	1	...	...	...	.....	.....
Developed in wards.....	4	1	2	1	40.00	100.00	6	50.00	1871
After operations.....	1	...	...	...	...	...	...	.....	.....
Developed in wards.....	14	7	2	4	14.28	50.00	22	27.27	1872
After operations.....	...	1	...	...	...	...	...	.....	.....
Developed in wards.....	5	4	...	...	...	20.00	17	11.76	1873
After operations.....	2	6	...	2	...	...	...	.....	.....
Developed in wards.....	18	5	2	...	10.71	18.75	44	13.63	1874
After operations.....	10	11	1	3	...	...	...	.....	.....
Developed in wards.....	13	13	3	1	20.00	5.88	32	12.50	1875
After operations.....	2	4	...	...	...	...	...	.....	.....
Developed in wards.....	11	4	3	...	23.52	.....	27	14.81	1876
After operations.....	6	6	1	...	.....	.....	...	.....	.....
	120	92	19	14	15.83	15.21	212	15.21	

Of the 212 cases, 120 were in males and 92 in females; 33 proved fatal,—19 of the deaths being males and 14 females; 72 cases of the disease followed operations done in the hospitals, and of this number only 8 died. In the remaining 140 cases, the erysipelas either originated in the wards, independent of operations, or outside of the institution, and were subsequently brought in, 24 of which were fatal,—the mortality being one-third greater in this latter class.

TREATMENT.—Not the least important in this connection are prophylactic measures. Much may be done to prevent the appearance of erysipelas in hospital or private apartments. To this end the most rigid attention to cleanliness, ventilation, and drainage should be given. The personal clothing and bedclothes should be frequently changed; the dejections must be disinfected and immediately removed, and all soiled dressings at once taken away; knives, scissors, dressing forceps, and sponges require to be thoroughly cleaned and immersed for a short time in carbolated water; and an ample supply of fresh air must be secured. Whenever a case is brought into or occurs in a hospital, the patient should be isolated at once, and placed as far as possible from the other inmates of a ward. The curative treatment may be considered under two heads, *general* and *local*.

General treatment.—In the use of constitutional remedies the surgeon must be governed by the variety and tendency of the disease. In the very mild form, that in which the inflammation is confined to the skin and not attended with any marked constitutional disturbance, there is very little treatment required, other than to have the intestinal secretions corrected by the administration of five or six grains of blue mass, followed by a gentle saline cathartic. After the bowels have been acted on, a dessertspoonful of neutral mixture may be given every two hours, each dose containing one-thirtieth of a grain of morphia. This combination is not only an excellent febrifuge, but also allays nervous restlessness and promotes sleep. The diet should be light, so as not to tax the digestive organs, and should consist for the most part of milk or beef-tea; and the apartment must be kept well ventilated and at a temperature comfortable to the sensations of the patient.

In the deeper variety of erysipelas (the cellulo-cutaneous, for example), in which both the local and the constitutional symptoms are more aggravated,

a more active treatment will be demanded. A mercurial purge may be exhibited, which should be followed by the tincture of sesquichloride of iron, and quinia.

The administration of iron in large doses (say twenty or thirty minims) every two or three hours, as directed by Hamilton Bell, who introduced the remedy into practice in 1851, is, in my judgment, of very doubtful propriety. I have obtained as satisfactory results by giving half the quantity. Quinine is a valuable drug in this disease, and may be administered in doses of two or three grains every two or three hours during the day. Nervous restlessness is best allayed by giving one-eighth of a grain of morphia in a tablespoonful of the effervescing mixture once in two or three hours, or by administering four or five grains of Dover's powder once every four hours. As the tendency of the disease is almost always asthenic, it is necessary to sustain the system by food and stimulants, for which purpose milk, milk-punch, and concentrated beef-essence should be given with regularity and frequency. As a rule, it is much better to give a moderate quantity of such articles at one time and at intervals of an hour, than a larger amount at longer periods. The nausea and vomiting which sometimes usher in an attack of erysipelas are best alleviated by carbonic acid water, or by frequent draughts of hot water. When the tongue becomes dry and dark, and the signs of general prostration are present, a turpentine mixture with carbonate of ammonia will be strongly indicated.

General blood-letting at one time occupied a conspicuous place in the treatment of erysipelas. Without pronouncing any judgment on the past, the circumstances which would justify the use of the lancet at present must be very exceptional. *Local blood-letting*, whether by cups or leeches, must have a very restricted application. In the early years of my professional work I frequently witnessed in idiopathic erysipelas the free use of the lancet, followed by nauseating doses of antimonials and saline purgatives. The patients were strong, robust country-people, and generally recovered, but, I suppose, got well in spite of the doctor,—as the convalescence was very slow.

Emetics have been alternately extolled and condemned. If there is evidence of a loaded stomach or a torpid liver at the time the disease makes its appearance, a gentle emetic of ipecacuanha will be productive of good by removing a source of irritation or by exciting the biliary and cutaneous secretions.

Purgatives, which for a long time played an important part among the revulsive remedies in erysipelas, frequently do good at the commencement of an attack; but when the intestines have been once cleared out their work is done, and any action on the bowels, other than that of an occasional laxative, does harm rather than good.

Iodide of potassium, at one time strongly recommended by Professor J. K. Mitchell, does not appear to exercise any controlling influence over the disease.

Mercurials.—By those who saw in every disease a biliary spectre, mercurials at one time were administered liberally during the course of erysipelas. That mercury possesses a peculiar power of correcting the secretions, and of course in this way of relieving the blood of deleterious matters, can scarcely be doubted; but I am disposed to believe that, except at the commencement of the attack, when a few grains of calomel or of blue mass should be given, preliminary to a saline cathartic, it may safely be dispensed with.

Local applications.—On the subject of local applications the profession has been, and still is, very much divided, some extolling and others deprecating their employment. The advocates of topical treatment differ greatly as to the remedies best suited for the purpose. Liquids, ointments, oils, and powders have all in turn been recommended. Among these may be named plain water, or water medicated with astringent salts, as the acetate of lead or sulphate of zinc; some contending that these evaporating lotions should be

cold, and others that they should be used warm. Among oleaginous agents, Betz attached importance to lime-water and sweet oil,—a mixture to which Dr. J. Forsyth Meigs is partial. Solon used inunctions of fat; Velpeau, Ricord, Wallace, and others, mercurial ointment. Glycerin, from its known property of attracting moisture and thus relieving muscular tension, has been used by Griscoms.

Higginbottom advised the topical application of a strong solution of nitrate of silver upon and around the inflamed surface. The tincture of iodine has been applied in the same manner. The power of limiting the inflammation has been claimed for the last two agents when painted over the skin beyond the limits of the affected surface. Tincture of sesquichloride of iron is another remedy, which has been used and strongly recommended for its efficacy by Garretson. Recently, the hypodermic injection of dilute carbolic acid into the cellular tissue beneath the inflamed surface has been recommended by Hueter. The same surgeon has used tar, an article which for many years was employed by Dr. Coates, of this city. Among the powders employed with which to dust the inflamed surface are rye-meal, starch, and lycopodium.

Pressure is a very old means of combating the inflammation of erysipelas, having been employed by Heister, and afterwards receiving the commendation of Bretonneau and the qualified sanction of Velpeau. The part, an arm, for example, was covered by a roller bandage, evenly applied from the fingers to the shoulder, and afterwards kept wet with water. The object was to moderate the inflammatory action by pressing a portion of the blood out of the vessels, and preventing the undue distention. In a number of instances the practice was followed by mortification of the limb, and as a result the method was abandoned.

Other remedies might be mentioned, as camphor, oil of turpentine, hyposulphite of soda, boracic acid, etc. I have used almost all the remedies to which reference has been made, and I am compelled to confess that the results have been so conflicting and negative in their character that I seriously doubt the power of any local application to modify in the least the course of the disease. Making the largest allowance for the discrepancy of human observations, all, I think, that can be claimed for this class of remedies is the palliation of that sense of stiffness, heat, and pain which is generally a very unpleasant accompaniment of this affection; and with this object in view a solution of the acetate of lead (3ss of the salt to ʒvi of water), to which may be added two drachms of laudanum, has fulfilled most perfectly the indication. A thin piece of old linen cambric should be wet with this lotion, lukewarm, laid over the surface, and renewed as often as it becomes dry.

Very different, however, is it with cases of *deep* erysipelas, where the subcutaneous cellular tissue is filled with the products of inflammatory infiltration. Here the value of local measures becomes paramount: the danger consists not only in the death of the cellular tissue by pressure on the blood-vessels, but also in disorganization of the deeper structures. When, therefore, the inflamed part presents the hard, dusky, and brawny appearance so characteristic of this variety of the disease, it should be covered with a light flaxseed-meal poultice, and carefully inspected on each renewal of the same. Should the induration, pain, and swelling not begin to yield in twenty-four hours, the tension of the tissue must be promptly relieved by a number of incisions, from three-quarters of an inch to an inch in length, made over the most swollen parts, and carried boldly down to the deep fascia, taking care to avoid any large vessel which may lie in the region. This will relieve the tension by allowing the escape of the inflammatory transudation, and will thereby invite the resolution of the local disease.

The manner of making these incisions must be determined by the locality. Over the extremities or upon the trunk they should run in the longitudinal axis of the limb or the body; on the scalp, somewhat oblique to the antero-

posterior diameter of the head, so as to favor the gaping of the wound; over the eyelid, parallel with the normal wrinkles, or in the direction of the fibres of the orbicularis palpebrarum muscle, in order to leave no visible scar. When the object is to open a way into the cellular tissue of the orbit, the puncture should be made beneath the palpebra, where the conjunctiva is reflected from the eyelid to the eye; and when operating on the face, the incisions are to be made in the course of the muscles of expression. On the trunk and extremities it is always better to make a number of short cuts rather than one long cut. As the vessels have been intensely congested, there sometimes follows quite a free bleeding, which, should it not cease spontaneously, must be staunched by placing over the wounds compresses first wet with hot water and then squeezed dry, and binding them to the part with a roller bandage.

After the incisions have been made, the poultices may again be applied, and continued for two, three, or more days, when they may be replaced by a warm-water dressing, and later by one of zinc ointment. When the induration is followed by a quaking or boggy feel, it is an evidence that the inflammation has culminated in suppuration, in which case free incisions must be made without delay, with a view to give exit to the unhealthy serum and pus, and also to furnish a way for the removal of the shreds of dead cellular tissue. These must be drawn away, as they separate, by the forceps, and the cavities or furrows syringed out at each dressing with a solution of permanganate of potash, of carbolic acid, or of sulphate of iron.* After the parts have thus been cleansed, poultices or warm-water dressings must be applied, covered with waxed paper or oiled silk. In some cases it will be necessary to pass a drainage-tube from one opening to another to prevent accumulations of matter. Twice a day it will be necessary to repeat this treatment of the wounds. As soon as the sloughs have been removed, the oxide of zinc ointment may be laid over the parts, and a roller applied with considerable firmness, so as to secure the adhesion of the skin to the subjacent parts.

When the disease attacks the throat, relief will be obtained by the inhalation of the steam from a hot decoction of chamomile flowers, by scarification, and by the free application of a strong solution of nitrate of silver (forty grains to the ounce of distilled water) to the tonsils, half arches, and pharynx.

Should the inflammation extend to the larynx, causing serious obstruction to the entrance of air, a careful exploration must be made with the finger, carried along the dorsum of the tongue, and, if œdema can be recognized, the part should be scarified by a curved bistoury, the edge of which can be shielded by being wrapped with a narrow piece of tape or by a strip of adhesive plaster, leaving about half an inch nearest to the extremity of the instrument uncovered. The finger will furnish the best director for conducting the knife to the offending point. In extreme cases laryngotomy or tracheotomy may be required.

Burns from Artificial and Solar Heat.

Practically, with regard to their effects, there is no difference between burns and scalds. Both are alike the result of a high degree of heat applied to the body. When the caloric is communicated from a solid body, as a piece of metal, it is called a *burn*; and when by a liquid or a vapor, as molten metal, boiling water, boiling oil, or steam, it is termed a *scald*. Burns, when caused by a heated solid body, are more circumscribed and extend deeper than when produced by liquids. The vast improvement in the arts and the multiplication of labor-saving machinery, with the ever-increasing industries and products of modern times, necessarily enhance the dangers of labor and

* The strength of these injections may be stated as follows: permanganate of potash, three grains to the ounce of water; carbolic acid, one part of the acid to forty parts of water; sulphate of iron, four grains to the ounce of water.

render accidents of this kind more common. In large cities a very great proportion of all cases of burns among the poorer classes are occasioned by coal oil; and notwithstanding the almost daily notice of such accidents in the public prints and the danger attending the use of lamps, little heed is given to these warnings.

As it is the duty of every organized community to conserve human life and health, I cannot conceive that it would be any exercise of arbitrary power, or savor in the least of sumptuary legislation, if it were rendered imperative that all houses built within the limits of city jurisdiction should be provided with gas, so as to dispense with those highly-inflammable oils so generally used by the poor for the purpose of illumination. A similar protection should be secured to those who are engaged in breweries and soap-manufactories, in which the most dreadful accidents of this nature occasionally occur. A netting might be stretched over the large tubs or caldrons containing the scalding liquids, which would in no way interfere with the proper manipulation of their contents and yet would render it impossible for operators, losing their equilibrium, to be precipitated into these great receptacles. Those parts of the body which are most exposed, and on which the skin becomes rough and callous by constant contact with rough substances, are rendered thereby quite proof against heat. In rolling-mills, forges, and smithies one is astonished to see the workmen handling with impunity pieces of hot iron which would blister an ordinary hand; and a quarryman will light his pipe from a live coal which he dallies with on the unprotected palm.

Fluidity often determines the extent of a burn, from the facility with which the liquid spreads over the surface: thus, boiling water, being less consistent than boiling oil, will involve a larger extent of surface, though the latter, from the manner in which it clings to a part, will inflict a deeper scald. Metals of the same temperature produce different degrees of burning, according to the readiness with which they part with their caloric. Volatile substances, like alcohol and ether, though very inflammable, are yet so rapidly consumed that their effects are superficial.

Burns have been variously classified. Sometimes this classification is based on the results of the ensuing inflammation, as suppuration, ulceration, and sloughing; at other times on an anatomical basis of tissue-planes, according as the skin, superficial fascia, muscles, and bones are implicated.

Dupuytren's division was expressed by degrees, six in number. In the *first* degree the injury consists only of an erythematous inflammation of the skin; in the *second*, of inflammation with vesication; in the *third* the entire cuticle and a portion of the true skin are destroyed; in the *fourth* the entire thickness of the skin is destroyed, the burn extending into the subcutaneous cellular tissue; in the *fifth* the superficial muscles are included in the damage; and in the *sixth* the deeper muscles, the bones, and, indeed, all the components of the limb, are involved.

Professor Gross adopts a more simple and better division,—that of *simple* and *complicated* burns; but as the most serious complication of internal organs may, according to this arrangement of the subject, follow a simple burn, I prefer to treat this subject under the same division as that employed in frost-bite, namely, 1st, burns followed by simple *redness*; 2d, burns followed by *vesication*, with or without ulceration; 3d, burns followed by *sloughing*.

1st. *Inflammatory redness, with or without vesication*.—This is the result of the momentary contact of a hot solid, liquid, or gaseous substance with the skin. It may be either circumscribed or diffused. The impression made on the cutaneous nerves, and, through them, on the vaso-motor branches of the vessels, is immediately followed by redness and slight swelling, and sometimes by minute vesicles,—the first from the sudden dilatation of the capillaries, and the second from the transudation of serum into the skin. These changes are accompanied by a burning, smarting pain. When of limited extent, this, along with the redness and swelling, subsides, and is followed perhaps by a slight

desquamation, leaving the parts very much as they were before the application of the irritant.

2d. *Inflammation, with vesication and ulceration.*—In addition to the symptoms present in the first variety, the transudation not only occupies the rete Malpighii, but also finds its way to the surface, raising the cuticle into vesicles. These may be small, distinct, and numerous, or they may be large, confluent, phlyctenular bags or blebs. The serum which they contain is either clear or bloody, according to the severity of the inflammation. Where the fluid escapes from the vesicles, through either a spontaneous or an artificially-made opening, the serum drains away, and the devitalized cuticle dries up and falls off, or is displaced by a rapid reproduction of new cells from below, the skin assuming gradually its ordinary appearance. The pain is of the same nature as that experienced in the first variety, namely, smarting and burning, but is rendered much more severe when the raw surface under the blisters is exposed to the stimulating influence of the air. The vesicles after their rupture sometimes have superficial abrasions, which degenerate into shallow ulcers, the surfaces of which are covered with pus and fibrin, imparting a stringy character to the suppuration, and giving to the burned region a red, raw, granulated appearance. A burn of this kind becomes intensely painful, with great nervous irritability. This is a consequence of the exposed condition of the terminal loops of the skin-nerves.

3d. *Inflammation following sloughing.*—Under this head are included all cases of burns in which the vitality of the parts is destroyed, whether skin, fasciæ, muscles, or bones. The eschar which results may be white, yellow, gray, or a charred black mass. When the injury penetrates beyond the integument, it is generally in cases where the unfortunate victim is confined in the fire or exposed to steam, as in the case of engineers in railroad or steamboat accidents. Such portions are separated in the form of sloughs by the processes of inflammation and suppuration, the resulting ulcers being exceedingly difficult to heal, and not uncommonly producing cicatrices which cause, by their contraction, the most horrid deformities.

Constitutional signs.—Following the local injury there is generally more or less constitutional disturbance, the severity of which may be measured by the superficial extent of the burn, by its location, and by the age of the patient. A foot or a hand may be reduced to a black charred mass and yet cause less general perturbation of the system than a burn of the simplest degree of wide-spread extent. A burn of the scalp, face, or chest is much more serious than one situated over other regions. Children also, from the extreme irritability of their nervous systems as compared with adults, endure badly the depressing effects of burns.

The constitutional effects of burns may be included under three heads,—*shock, inflammatory fever, and exhaustion.*

Shock.—In severe cases the pulse is feeble and frequent, the respiration embarrassed, the surface cold; there are shiverings, great restlessness, sickness of stomach, and an unquenchable, agonizing thirst. "For the love of God, dear, dear friends, give me water, water, cold water! Why will you deny such a pittance to a poor, dying wretch?" continually cried a negro woman, who was fast sinking under a dreadful burn, as I passed her bed in going, one morning, my hospital rounds: she had the cup to her mouth while uttering the touching appeal. Martyrdom at the stake, I take it, is something more than a mere sentiment, as some persons would have it.

Many persons never recover from the shock, but sink into a hopeless collapse, and die within the first twenty-four or thirty-six hours. The blood under such circumstances accumulates in the internal organs, producing in some instances intense congestion of the brain and its meninges, and in others a similar condition of the organs of the thorax or the abdomen, not unfrequently accompanied with effusion.

2d. *Inflammatory fever.*—Should reaction occur, inflammatory fever of a continued type sets in, exhibiting a tendency to produce inflammation in

those organs which suffer during the stage of shock from congestion. The severer cases of this fever continue from one to two weeks, during which time many persons die from bronchitis, pneumonia, peritonitis, gastro-enteritis, arachnitis, and ulceration. Not a few young subjects perish from tetanus. Among these secondary accidents are ulceration and perforation of the duodenum, first noticed by Curling. The lesion, commencing as an inflammation of the mucous membrane, extends rapidly through all the coats of the intestines,—death following, either from extravasation of the intestinal contents, creating peritonitis, or from hemorrhage. This ulcer occurs about once in every four or five fatal cases of burns in which the patient survives the stage of shock: though in exceptional instances it may appear as early as the fourth or fifth day, yet the usual period for its development is about the tenth day following the stage of reaction.

There are no symptoms which are certainly diagnostic of the presence of duodenal ulcer. The sudden invasion of pain in the left hypochondriac region, vomiting of blood, strained stools, and abdominal tenderness, will form reasonable grounds for conjecturing its existence. No satisfactory explanation has yet been given why this particular portion of the intestinal tract should be more prone to perforation than another; there is no evidence to prove that the duodenal or Brunner's glands are capable of supplementing defects of, or exchanging offices with, the perspiratory glands of the skin, or that when the latter are rendered helpless by a burn of the surface the former are overtasked. This was the explanation given by Curling. Nor does the doctrine of capillary embolism, advocated by Feltz and others, offer any better solution of the problem. For, if the blocking-up of the minute branches of the pancreatico-duodenal artery explains this structural change, why should not similar perforations be seen in other sections of the intestinal canal, where inflammation of the mucous membrane and embolism are quite as frequently present?

In addition to the fever of irritation, another element of exhaustion is encountered, in the suppuration which attends the separation of the devitalized tissues, and in the course of which the patient frequently dies, worn out by exhaustion, or as the result of secondary inflammation of internal organs, notably of those within the chest. About one-third of all fatal cases occurring during the separation of sloughs, and the attending suppuration die from pleuro-pneumonia and its sequelæ, as sero-purulent accumulations in the pleural cavity, and red and gray hepatization of the lung-tissue. Why the contents of the thorax are selected, as a rule, by the disease, rather than those of the abdomen or the cranium, is a question not easily answered. The cutaneous nerves are all exciters of respiration; and a certain degree of aeration is also effected through the vast capillary net-work of vessels which interpenetrate the skin. The sudden interruption or disturbance of the relation between these two functions (that of the skin and that of the lungs) which results from the destructive operation of a burn or a scald may be no inconsiderable factor in explaining the frequency with which the lungs suffer during the period under consideration. Again, the frequency of pleuritis and pneumonia during the winter months shows a very significant interdependence between the cutaneous and the respiratory function.

Prognosis.—The circumstances to be taken into consideration with reference to the probable issue of a burn are the same as those which have been noticed in connection with the grades of constitutional disturbance.

The danger is in proportion to the extent of surface involved, however slight may be the cutaneous inflammation. When it exceeds more than one-third of the superficies of the body, it is an old and true observation that recovery rarely takes place. I do not remember, certainly, more than two exceptions to this rule in my own experience. Deep burns which are local become serious in proportion to the amount of subsequent suppuration. In burns over the chest or the abdomen, the danger of intra-thoracic and abdominal inflammation is augmented; and so, when on the face or the head,

the risk of meningitis or cerebritis is increased. The very young and the aged are much more likely to succumb to a burn or scald than persons in middle life. The largest number of deaths after burns or scalds (over 50 per cent.) occur during the first twenty-four hours following the accident; the next most fatal period is between the eighth and the thirteenth day. Of 305 cases of burns or scalds received into the Pennsylvania Hospital between the years 1859 and 1879, 144 died and 161 recovered; and of the 144 deaths, 111 were from shock, and 33 from secondary inflammation of internal organs and from exhaustion. Of the 111 cases dying from shock,

FIG. 1236.



Deformity following a burn of the face and neck.

77 perished within twenty-four hours, 13 within forty-eight hours, 8 within seventy-two hours, 7 within ninety-six hours, and 6 within one hundred and twenty hours. Of the 29 deaths which occurred from secondary causes, 11 were within nine days, and the remaining 18 between the thirteenth and the one hundred and thirteenth day; 4 of the 33 deaths were from tetanus, occurring respectively on the ninth, the twelfth, the fourteenth, and the fifteenth day. Even when the subject of a severe burn escapes with his life, there remains a liability to a variety of serious consequences from the resulting cicatrices causing unsightly deformities, according to the seat of injury,—as eversion of the eyelids and contortions of the lips and mouth; drawing the head to one side (Fig. 1236), or the chin towards the sternum (Fig. 1237); uniting the fingers; tying the arm to the side, causing contractions of the limb

(Fig. 1238) and ankylosis of the joints. These cicatricial scars, at first red,

FIG. 1237.



Chin drawn towards the sternum by the cicatrix following a burn.

FIG. 1238.



Arm flexed and bound to the side by an extensive cicatrix following a burn.

become after a time abnormally white, puckered, and elevated into ridges. They frequently undergo a keloid transformation, having a blue or lilac color,

and sometimes becoming very sensitive. Malignant disease is occasionally developed in the cicatrix of an old burn.

TREATMENT.—The indications are to relieve shock, to alleviate pain, to prevent secondary inflammation of internal organs, to favor the separation of sloughs, to support the general system, and to prevent deformities. To carry out these objects, the management of a burn or a scald necessarily involves constitutional and local treatment.

CONSTITUTIONAL TREATMENT.—The *shock* which attends severe cases of burn or scald demands immediate attention. Opium in some form is invaluable, and must be given in doses sufficiently large and frequent to allay the dreadful distress which patients experience. Stimulants, when the collapse is well marked, will also be required, as brandy, whisky, carbonate of ammonia, and wine, but when the symptoms of depression are not very pronounced it is better to abstain from their administration, for they will only add to the violence of the reaction. When there is difficulty in swallowing, the anodynes can be used hypodermically, and the stimulants administered by the rectum. External warmth must be applied to the spine, extremities, and epigastrium. This is most conveniently done by means of heated bricks or bottles of hot water rolled in pieces of flannel, or by hot-water bags. When reaction sets in there follows the danger of internal inflammations. As these are probably dependent, to some degree at least, on the deranged functions of the secretory apparatus of the skin, it should be the aim of the practitioner, as much as possible, to keep in action those organs which are capable of performing a vicarious work for the skin, namely, the intestines and the kidneys. A saline laxative from time to time will increase the activity of the intestinal glands; and fifteen or twenty grains of bicarbonate of potash dissolved in half a pint of water, and drunk in the course of twenty-four hours, will stimulate the renal organs. During the period of suppuration it will be necessary, by tonics and good food, to sustain the general strength. Should tetanic symptoms threaten or convulsions occur (not an uncommon complication in young subjects), they must be combated, the former by anodynes, as *landanum* or *chloral*, given in conjunction with bromide of potassium, and the latter by hot foot-baths and bromide of potassium. Vomiting is sometimes a troublesome attendant of burns or scalds, and is best corrected by small draughts of hot water, or by lime-water, or, should these means fail, by oxalate of cerium, or diluted prussic acid, along with very minute doses of morphia. *Diarrhœa*, when present, is best managed by full doses of subnitrate of bismuth and opium.

LOCAL TREATMENT.—The profession has been somewhat divided as to the manner of dealing with the local inflammation resulting from burns, some advocating the use of sedative applications, such as cold, and others the use of stimulating agents. The nature of the local applications must be determined by the depth and the extent of the burn. When the injury is a slight one, such as frequently occurs from unwittingly taking hold of a piece of hot metal with the fingers, or from overturning a small vessel containing hot water, common sense will lead any one, instinctively, to apply cold; and nothing so promptly gives relief as plunging the part into cold water, or enveloping it with wrappings of old linen and keeping it wet. The addition of a little *landanum* to the water produces a very soothing effect. The effect of cold is enhanced by elevating the part, when it is feasible, so as to lessen the amount of blood in the inflamed tissue.

After persisting in these measures until the smarting, burning pain is lessened, a firm and evenly-applied roller will supply a useful support to the vessels, and favor the resolution of the inflammation. When the burn includes a wide extent of surface, the application of cold is usually objectionable, as by lowering the temperature of the skin and repelling the blood from the cutaneous vessels the chilliness and shock are increased, as well as the danger of secondary internal inflammations. Under these circumstances, covering the burned surface with pieces of old linen smeared

with benzoated oxide of zinc ointment, and enveloping the whole with a layer of cotton batting, constitutes, in my experience, the most satisfactory dressing. Dupuytren was partial, in burns of a superficial nature, to the use of a solution of Goulard's extract, applied by moistening pieces of linen with the liquid. Where vesicles or phlyctæna are present, they should be punctured on a level with the common surface, and their contents carefully pressed out, but without detaching the cuticle, which should be gently flattened down before the application of the zinc ointment. There should also, in such cases, be sheets of waxed paper interposed between the linen on which the ointment is spread and the cotton batting. The contact of the atmosphere with the raw surface of a burn is exceedingly irritating; the cotton renders the dressing impervious to air, and when it becomes moistened with the discharges it can be withdrawn with the minimum of injury to the abraded surface. Burns of the degree under consideration should not be dressed oftener than is absolutely necessary: once in three or four days may be quite sufficient, this being determined by the amount and the nature of the discharges. An offensive odor is always an indication for the renewal of the dressings.

Great injury and pain are often inflicted by removing the clothing from persons who have sustained a severe burn. Large sheets of the cuticle are sometimes torn off in this way, leaving a raw, sensitive, and exposed surface. When, therefore, by gentle manipulation, a shirt or a stocking or the leg of the trousers cannot be readily disengaged from the blistered surface, it will be better to apply cold water until this can be accomplished.

Not unfrequently the burned part will be found covered with flour or some other powder, one of the popular domestic remedies for this class of injuries. The discharges becoming incorporated with these materials form a hard crust, the forcible separation of which from the surface of the burn is calculated to do much harm. Where such a crust has formed, it should be allowed to remain until the detachment takes place spontaneously. This may require some time; but the surgeon will often be rewarded for the non-interference by finding that cicatrization has been completed beneath the scab.

A great variety of other agents are in use. The Carron oil, consisting of equal parts of linseed oil and lime-water, and named from the Carron Iron-Works, in Scotland, where the remedy was much employed among the operatives for the treatment of burns, is still in very general use. It is a soothing and valuable mixture, having only the objection of an offensive odor, which is greatly lessened, and without detracting much from its value, by substituting olive oil for the linseed oil. Professor Gross speaks favorably of white lead, used in the form of paint, and laid over the part with a soft brush: it is quite as efficacious as the Carron oil, and is a much more agreeable application. Dr. Packard employs fresh lard. Turpentine and ointments or oils containing a small quantity of carbolic acid have also their advocates. When there is a raw and painful surface, the addition of carbolic acid to oxide of zinc ointment, in the proportion of two or three grains of the former to an ounce of the latter, has a very soothing effect, on account of the anæsthetic properties of the acid. In severe burns or scalds, where there is more or less sloughing, exposing the rete Malpighii of the skin, stimulating applications will be found most useful, and among these the ordinary resin ointment, adding to each ounce one drachm of turpentine (Kentish ointment), I find to answer every purpose. Dr. Read, of Conshohocken, Pa., besides the turpentine, adds a small quantity of phénol sodique to the resin ointment, a combination of which I can speak favorably from experience. Dr. Addinell Hewson advocates wet clay.

When the vitality of the integument has been destroyed, the parts being burnt into a crisp, the sooner its separation as a slough is effected the better; and with this view, after using for a few days a lotion of lead-water and laudanum, applied by wetting old pieces of linen with the liquid and wrapping them round or placing them over the damaged part, we may resort

to flaxseed-meal poultices, renewed three times every twenty-four hours. As soon as suppuration has been well established and the dead tissue begins to loosen, the devitalized fragments must be picked away, the parts thoroughly cleansed with deodorizing washes, as permanganate of potash, diluted alcohol, or Labarraque's solution, and the poultices rendered stimulating by smearing over their surface a quantity of the compound resin or Kentish ointment. After the dead tissue has all been removed and granulation has commenced, special attention must be given to the treatment of the ulcers.

Treatment of the caloric ulcer.—If the granulations are indolent, they may be stimulated with sulphate of copper or nitrate of silver; if redundant, the latter agent, if freely applied, aided by pressure with adhesive strips, will serve to repress their exuberant growth. Though no remedy will so modify the character of the granulations that the cicatrix will lose the property of contraction, it has appeared to me that a solution of caustic potash (three grains of the alkali to one ounce of water), applied lightly over the granulations every day or two during the process of healing, does in some degree lessen this tendency. Generally we endeavor, by approximating the sides of a granulating sore, to render the cicatrix as small as possible. Not so in the ulcer following burns: here the object is to enlarge the extent of the cicatrix, so as to provide for its subsequent shortening. Accordingly, in burns of the extremities, near the articulations, and on the aspect of flexion, the limb must be maintained in an extended state by the addition of a properly-constructed splint. If the burn or scald involves the axillary region, the arm must be preserved in the posture of abduction; if the neck, the head must be extended, to prevent the chin from bearing down towards the breast. When the hands or the feet are scalded, the opposing or raw sides of the fingers or toes must be kept asunder by the interposition of strips of oiled lint, and rolls of the same should be fitted into each interdigital cleft. If these points are neglected, webbed fingers or toes will be the result. When the ulcer is situated at the margin of the outlets of the body, as the nose, mouth, etc., appliances of lint or hard rubber should be introduced into these openings. It is necessary to use these mechanized appliances not only during the progress of healing, but also for several months after the completion of that process.

Treatment of cicatrix.—We have in the process of skin-grafting a most valuable resource to remedy contraction, and one which should never be omitted. In this way it is possible to secure not only the cicatrization of ulcers which otherwise would not heal at all, but also to obtain a cicatrix free from the vicious propensity to create deformity. The cicatrix following a burn or a scald, if not too old, may, under the influence of mechanical measures (as the traction of a weight suspended, for example, from a contracted leg, or an anterior splint with a Stromeyer screw applied to the arm), be somewhat elongated. When, however, the new tissue becomes ancient, or of six or eight months' standing, little, if any, advantage can be expected from such expedients. Under these circumstances, and when contraction seriously interferes with the functional use of a part, the question of correcting the evil by an operation must be considered. The simple division of the cicatricial band can be productive of no permanent benefit, since the gap which results will be filled up by granulation-tissue of the same nature as that which has been severed. No operation can be of any permanent benefit which does not substitute healthy skin for the inodular tissue, and there are only two ways in which this can be done, namely, either by lateral approximation or by transplantation of sound skin. Whichever of these methods is adopted, the surgeon must make his incisions so as to include, both in width and in depth, the cicatricial tissue.

Relief of cicatricial contraction by lateral approximation of sound skin.—This plan is applicable only to cases in which the inodular tissue is narrow and prolonged to a point. The operation consists in making an incision in the sound skin on either side of the tongue-shaped prolongation of inodular tissue, and through the entire depth of the integument, dissecting up the

cicatrix and sliding it back. The triangular chasm which results is now to be closed by loosening up the integument on each side and bringing the edges together. Fig. 1239 illustrates the principle of this operation.

FIG. 1239.



The tongue-shaped cicatrix which flexed the forearm has been dissected and slid back, and the sutures inserted ready for approximating the sides of the wound.

When the cicatrix is very extensive, the evil may still be corrected by the transplantation of sound tissue from the vicinity of the scar. Thus, in the neck, a flap of integument may often be obtained from the front of the chest or from the shoulder; and when the scar is on the skin or the lower border of the face, a healthy flap can be raised from the neck. Even should the gap left after the removal of the cicatrix be only imperfectly closed by the new flap, much will have been gained in lessening the amount of inodular tissue, and the remaining part of the ulcer may be treated with skin-grafts. The rules governing these procedures are the same as those prescribed under the head of plastic operations.

Amputation may become necessary after burns, where a limb is found so hopelessly distorted that it constitutes a positive hinderance to movement, or where the bones

have been exposed by sloughing and the patient's strength is failing under an exhausting suppuration.

Frost-Bite, Chilblain, Pernio.

Severe cold causes a peculiar inflammation of the skin commonly described as frost-bite, the effects of which are designated chilblains and pernio. The portions of the body which generally suffer are those farthest removed from the centre of the circulation, as the toes, the fingers, the tips and lobes of the ear, and the end of the nose. Those who suffer most from this affection are persons who, by their occupations, are compelled to be much in the open air during the winter months, as soldiers, sailors, teamsters, policemen, and out-door laborers in general.

A low temperature, if the air is dry, is much less likely to produce chilblain than the same temperature or even a somewhat higher temperature when the atmosphere is loaded with moisture. Moisture is particularly favorable to frost-bite: a wet foot or one which perspires very much is less able to resist the evil effects of cold than a dry one.

Whatever tends to diminish the activity of the capillary circulation constitutes a predisposing cause of chilblain. Among such causes we may enumerate a feeble heart, scantiness of raiment, both of the body and of the extremities, deprivation, fatigues, and alcoholic stimulants. The popular idea that alcoholic stimulants constitute a means of resisting the injurious operation of a low temperature is utterly unfounded. The excitement which they temporarily produce is followed by a corresponding depression of nerve-energy, leaving the skin even more helpless against the effects of cold, and the mental stupor which they induce renders the person given to such indulgence less quick to appreciate the danger to which he is exposed.

Varieties.—There are four degrees of chilblain: 1st, simple redness or inflammation of the part; 2d, vesication; 3d, ulceration; 4th, mortification.

1st. *Simple inflammation.*—In this degree of frost-bite there are heat, redness, itching, and slight swelling. When the inflammation is more strongly pronounced, these symptoms are all aggravated; the color is purple or bluish, the heat burning, the itching intense, the pain severe, the swelling conspicuous; all of which symptoms are intensified by the warmth of the bed or when the patient approaches the fire. These paroxysms of suffering, though generally

greatly influenced by the state of the weather or the season of the year, occasionally recur daily or even twice a day, and sometimes with a singular regularity in their periodicity.

2d. *Inflammation with vesication*.—In this variety, in addition to the redness, there are present one or several vesicles which are filled with a blood-stained serum. These vesicles, after the discharge of their contents, may dry up and be replaced with a sound epithelium, or they may degenerate into ulcers, forming the third degree of the disease.

3d. *Ulcerative chilblains*.—The ulcer or ulcers succeeding the vesication have an unhealthy aspect, discharge a thin, serous, ichorous pus, and are associated with a marked diminution in the sensibility of the parts. Nor do they always remain superficial, but, on the contrary, destroy the subjacent parts, even to exposing the periosteum and the bones.

4th. *Mortification*.—In this last degree of frost-bite the redness is followed by the appearance of blebs filled with bloody serum, and the color of the surface changes to a blue and then to a cherry red, which betokens the certain dissolution of the parts.

Action of cold.—The first effect of cold on the body is stimulating. A keen, frosty air heightens the color of the cheeks and brings a pleasant glow over the face, and the same to the ungloved hand, as the blood rushes into the capillary vessels. In this respect heat and cold operate alike. If the exposure continues and the cold is severe, the blood recedes from the surface, the temperature falls, and the part becomes pale, shrunken, stiff, numb, and insensible. If now the hand or the foot in this condition is placed in warm water, or held to the fire, a violent reaction follows; the parts begin to redden, tingle, burn, and finally to ache. Gradually the stiffness passes away, the equilibrium of the circulation is restored, the sensibility returns to its normal state, and no evil may result. Should, however, the reaction be so violent as to overstrain and paralyze the engorged capillaries, there follow undue redness, transudation of serum, giving rise to some swelling, and disordered nerve-action, as shown by the severe burning, itching, and pain experienced, which phenomena, collectively considered, constitute frost-bite. The more aggravated forms of the disease, namely, those accompanied by ulceration and mortification, are expressions of a more intense degree of inflammation.

Besides these local effects of cold there are others which are general, affecting the system at large, and which are attended by a gradual depression of the functions of organic and animal life. The surface becomes cold, stiff, and numb, the circulation feeble, and the respiration scarcely noticeable, while a sense of drowsiness steals over the person so irresistibly as to demand an almost superhuman effort of the will to resist it. Should the unfortunate victim, failing to appreciate his danger, surrender to this treacherous feeling of slumber, he is probably lost: it is the icy sleep of death, which locks up the vital fluids and stops the wheels of life. Larrey, in his "Memoirs," gives a graphic description of the effects of severe cold on the French army during the disastrous retreat from Russia after the fall of Moscow. The remarkable power of man to resist the intense cold of high latitudes has been well exemplified in the reports given by Arctic explorers, among the most eminent of whom of our own country are the late Dr. Kane and Dr. Hayes.

TREATMENT.—The treatment of frost-bite is *preventive* and *curative*. To avoid the ill effects of a low temperature, the body and extremities should be warmly clad. Tight-fitting boots or gloves are particularly dangerous, as they not only embarrass the circulation and leave no space for a stratum of warm air, but also prevent motion of the parts encased. When, after long exposure to cold, a part is threatened with frost-bite, it is of primary importance that the circulation and the sensibility be very gradually restored: accordingly, the application of heat is to be deprecated. The benumbed and insensible parts should be rubbed with snow or finely-broken ice, or, in the absence of

these, they may be placed in cold water for a short time, and, after being removed, briskly rubbed with a woollen cloth moistened with alcohol. In this way, the reaction being very cautiously established, the danger of frost-bite may be averted.

When the whole body is partially frozen, the same caution must be observed with reference to the sudden change from cold to heat. The person must be first brought into a room without fire, and all wet or damp clothes should be removed and dry ones substituted. The limbs and body are next to be subjected to continuous rubbing with the hands or a piece of soft woollen cloth. The respiration must be sustained, when necessary, by holding to the nose some volatile preparation of ammonia and by keeping up artificial breathing. Warm drinks, as coffee, tea, or wine-whey, will assist in stimulating the heart, and, when the patient cannot swallow, milk, with a little brandy, may be thrown into the bowel by injection. When the respiration and circulation have been measurably restored, the temperature of the room may be cautiously raised; and, in order that the reaction may be quickly established, resort should be had to friction with snow or ice-water, and, as soon as the natural temperature returns, for these should be substituted something of a more stimulating nature, as soap liniment or alcohol, so as to impart tonicity to the walls of the capillaries and prevent congestion.

The curative treatment for chilblain is very unsatisfactory. When the disease is slight, consisting only of some undue redness or a mottled condition of the skin, with itching and burning, relief may be obtained by the use of stimulating applications. Those which are commonly employed are turpentine, tincture of iodine, dilute carbolic acid (one pint of the acid to nine pints of water), soap liniment, or the latter with tincture of cantharides (two parts of the tincture to six parts of the liniment), generally known as Wardrop's liniment. Venice turpentine, mixed with a little lime-water and volatile liniment, will often give very prompt relief from the severe burning itch which is likely to harass the patient as soon as the feet or the hands become warm in bed. The use of dilute nitro-muriatic acid is also attended with good effects. No one remedy, however, will answer in every case, and the surgeon must try one after another until the proper one has been discovered. Even after the symptoms subside they are liable to reappear on slight changes of temperature, so that many persons are never entirely freed from periodical attacks of the inflammation.

When vesicles form, a strong solution of nitrate of silver (fifteen grains to half a drachm of distilled water), or a mixture of collodion and Venice turpentine, may be brushed over the part with advantage.

The ulcers which result from frost-bite are also quite intractable to treatment: they should be touched with a crayon of nitrate of silver or sulphate of copper, and afterwards covered either with a strip of soap or adhesive plaster. Penciling the surface with an ointment of iodoform and gallic acid (three parts iodoform, one part gallic acid) will be found advantageous; and good effects also follow a light application of acid nitrate of mercury.

When the vitality of the part is destroyed, decomposition sets in, and the same treatment will be indicated as in mortification from other causes. Fermenting poultices are to be applied, that the process of separation may be hastened. Any fetor which is present should be destroyed by the use of permanganate of potash, nitrate of lead, or chlorinated soda.

Sloughs, as soon as it is feasible, are to be removed, and when the line of limitation between the dead and living tissues is well established, should the case be one for amputation and the general condition be favorable, the operation must be performed. It is thought by some that persons suffering from mortification as a consequence of frost-bite are peculiarly liable to pyæmia; but this opinion has certainly received no support from what is observed in American hospitals. While attending to local treatment, the *general system* must not be neglected. It will require to be liberally supported by nourishing food and the use of tonics.

Sunburn.

Exposure to the sun's rays for any considerable length of time will frequently cause a peculiar kind of burn in persons possessing a delicate skin. Women are more prone to such cutaneous irritation than men, and the parts which suffer most are the face, neck, and arms.

The skin becomes red, painful, and swollen, and sometimes vesicles appear. In a few days thin, exanthematous crusts form, become fissured, and are followed by a free desquamation.

As a prophylactic measure, protecting the parts most exposed to the sun by clothing, veils, and umbrellas will enable most persons to escape the irritating effect of solar heat. Cosmoline and vaseline may also be smeared over the skin with advantage. To relieve this inflammation when once present, nothing answers the purpose better than these same articles, to which may be added benzoated oxide of zinc ointment.

Lightning-Stroke.

The few writers who have observed injuries of the body caused by lightning describe them as being often of a mixed character, and consisting of shock, cerebral concussion, and burn. Frequently the electric stroke is sufficiently intense to produce instantaneous death; or it may cause such a disturbance of the brain as to induce paralysis of the limbs, or the loss of special sense. The traumatic effect of the electric fluid is often seen in the surface of the body being scorched; and Stricker has figured certain arborescent lines which are represented as witnessed on the body in some fatal cases of this injury. When sudden death follows a stroke of lightning, the blood remains uncoagulated and the heart empty. In slight cases of stroke, when the patient is momentarily stunned, but soon regains his mental equilibrium, nothing more is required than to preserve for a short time the horizontal position. In severe cases, where there are only slight evidences of animation, external warmth and artificial respiration must be maintained. The paralysis which occasionally follows this injury is not regarded as altogether hopeless, many cases recovering after a long time. Galvanism and strychnine are remedies which have been employed in such cases.

CHAPTER XXIII.

INJURIES AND DISEASES OF THE GENITO-URINARY ORGANS.

UNDER this chapter will be considered all those casualties and diseases which affect the penis, the scrotum, the testes, the spermatic cord, the prostate gland, the bladder, the urethra, and the kidneys.

Injuries and Diseases of the Penis.

Injuries of the penis may be divided into those affecting the integument, those affecting the body, and those affecting the urethra.

Wounds of the Integument.—These may be incised, lacerated, contused, and gunshot.

Incised wounds bleed freely, but rarely demand the use of ligatures. Their edges should be brought together by interrupted sutures, and afterwards dressed by enveloping the organ in a piece of old linen wet with simple water. These wounds usually heal very kindly.

Lacerated wounds are sometimes caused by persons falling upon hooks or becoming entangled in machinery. The frenum is not unfrequently torn during coitus, and the resulting hemorrhage is sometimes very profuse and prolonged, and may demand the application of a thread. If the vessel is not readily isolated, the oozing surface may be gathered up with a forceps, and a thread placed round the mass, as in tying the neck of a sac. Other lacerations it will be proper to treat in the same manner as incised wounds, by interrupted sutures, so as to counteract the tendency to retraction. Luke-warm water is the best subsequent dressing.

Contusions of the integument of the penis frequently result from kicks, from falls astride fences, wheels, etc. Extensive diffused extravasation of venous blood through the cellular tissue of the integument often follows such injuries, giving rise to a dark discoloration, which may extend to the scrotum. Little treatment is required in a case of this nature. Cold applications may be used at first, and after eight or ten hours a lotion of dilute alcohol or of tincture of arnica will meet every indication.

Shot wounds affecting only the integument of the penis, independent of its body, rarely produce any special inconvenience; such injuries are followed, as in shot wounds elsewhere, by the separation of a layer of disorganized tissue before closure by granulation can occur; and hence the employment of sutures is useless, the water dressing alone being required. If, after the lesion, the integument becomes red, swollen, and indurated, swathing the organ with lint or old linen saturated with water, and surrounded with oiled silk or waxed paper, will prove of great value; or flaxseed poultices can be substituted with equal advantage.

Diseases of the Integument.—These are situated chiefly over the prepuce. Those having an inflammatory origin are œdema, balanitis, herpes, eczema, and hypertrophy.

Edema of the prepuce, in consequence of the extreme distensibility of the structure, is almost invariably the sequel of operations on this part of the penis; but in infants more commonly than in adults there exists an idiopathic, sometimes almost transparent, collection of serum in the lower semi-circumference of the prepuce, to which part the fluid naturally gravitates. This

swelling is frequently induced by irritation arising from the preternatural length of the foreskin, from the friction of diapers, and occasionally from the scalding effects of the urine. The disease quickly yields to a lotion of lead-water and laudanum, and it is scarcely ever necessary to puncture the swelling in order to get rid of the serum.

Posthitis, when not originating from a specific cause, such as gonorrhœa, is due to the decomposition of the smegma which collects between the glans penis and the prepuce. The inflammation is limited for the most part to the mucous surface of the foreskin, which, in adults especially, becomes abraded and moist, in consequence of the rapid desquamation of its epithelial covering. The disease may commence as a balanitis, and extend to the prepuce. It may also be caused by the part rubbing against rough portions of the clothing, and by contact during coitus with irritating vaginal discharges other than those of a gonorrhœal nature.

The treatment consists in removing, as far as it is ascertainable, the provoking cause. When, as is usually the case, this cause is inattention to personal cleanliness, frequent ablutions with warm water may be practiced, injecting the fluid beneath the prepuce, if the latter cannot be retracted, until all the caseous matter has been discharged. When occasioned by rude contact with the clothing, in addition to bathing the parts with hot water, the use of benzoated oxide of zinc ointment will be found to remedy the evil quickly.

Should the inflammation have been provoked by vaginal discharges, the addition of a few grains of acetate of lead to the ointment will hasten the cure. In cases where the disease shows a tendency to relapse, I have found a powder of calomel and subnitrate of bismuth (equal parts) to be very efficient. Lotions or injections of alum and of borax may also be employed. Should the inflammation, in defiance of these measures, prove unmanageable and the prepuce be redundant, the only resource is circumcision.

Preputial concretions.—Preputial irritation may be caused by the presence of concretions which are formed by depositions from the urine and composed for the most part of uric acid. There may be a single one or many such stones imprisoned beneath a tight foreskin. Their presence may be recognized by the solid character of the enlargement, and the remedy is incision or circumcision, not only admitting of the ready removal of the foreign bodies, but also preventing them from reforming, by establishing a free outlet for the urine.

There is a variety of inflammation of the prepuce which I have met with that is secondary to urethritis, and that is peculiarly distressing, the swelling extending in some instances much beyond the limits of the foreskin,—indeed, even to the entire organ. The irritation and pain are always greatly aggravated by urination. The inflammation of the urethra, on which the disease depends, may be the result of a previous gonorrhœa, or may be caused by mechanical injury, as the impaction of a fragment of stone in the canal. The urethral inflammation must be combated by mild astringent injections of nitrate of silver or sulphate of zinc, assisted by warm fomentations of the penis with laudanum and water.

In one case of this disease which I had under my care the suffering was so aggravated by the passage of the water that the benefit obtained from local treatment in the intervals of urination was altogether lost. The soft catheter, under the circumstances, I believed would be a lesser evil than the water; and the result proved the correctness of this opinion, as no improvement took place until the adoption of the expedient of drawing the water with that instrument at stated periods.

If the patient is harassed during the night with a desire to rise and empty the bladder, the use of a suppository of opium will become necessary for the purpose of allaying vesical irritation and procuring rest.

Herpes appears as a crop of white vesicles surmounting a red base, and located near the junction of the skin and mucous membrane of the prepuce. After the vesicles open there is left a cluster of itchy, superficial sores. Per-

sons of light complexion and delicate, fair skins are the most common subjects of the disease. The vesicles occur in groups, and are prone to recur. Their crusts frequently cover shallow ulcerations, and require to be carefully removed in order to disclose the true character of the affection.

When not arising from gonorrhoeal or syphilitic causes, herpes will often be found to depend on some derangement of the intestinal secretions. A cathartic, preceded by a few grains of blue mass or of calomel, will often suffice for the removal of the eruption. The best local application, after bathing the parts with warm water, is a layer of calomel dusted over the vesicles, or an ointment consisting of calomel, acetate of lead, and benzoated lard (calomel grains x, acetate of lead grains iii, benzoated lard ʒii).

Eczema is more diffused than herpes, the redness, heat, swelling, and irritation extending beyond the limits of the foreskin. The inflamed surface is covered with minute vesicles, which, on opening, leave the skin at first moist and afterwards covered with crusts or scales. The disease is rarely seen on the penis unless at the same time occupying other parts of the body. When not dependent on a contracted prepuce it is quite amenable to ablutions associated with a lotion of lead-water, or to the use of a wash of black-wash and tar-water.

Hypertrophy of the inferior semi-circumference of the prepuce is a frequent sequel to chancre, and may also become a permanent condition after the operation of slitting up the foreskin in cases of phimosis where the integument is redundant. The enlargement is the result of an inflammatory infiltration, which subsequently becomes organized into connective tissue. When the hypertrophy is sufficiently important, from its bulk, to demand attention, the most expeditious and thorough remedy is to remove an elliptical portion of the growth with the knife, and afterwards unite the edges of the wound by the interrupted suture. During the healing the penis should be turned up against the pubes and so retained, to prevent the gravitation of inflammatory products to this part of the foreskin.

There is a general hypertrophy of the integument of the penis which partakes of the nature of elephantiasis. Mr. Bryant mentions a case of this kind, which, though giving a monstrous appearance to the organ, seems to have been regarded by its owner as a rare possession, he having declined to have anything done for its removal.

To reduce a hypertrophy of this nature the organ should be surrounded with a roller bandage applied daily with increasing firmness, and kept under constant water irrigation. In elephantiasis of the scrotum the penis participates in the hypertrophy.

FIG. 1240.



Phimosis.

Phimosis (from the Greek *φίμω*, "I bind") is a term used to express a preternatural elongation of the prepuce, with a contraction of its orifice to a degree rendering it difficult, and in many instances impossible, to uncover the glans penis. (Fig. 1240.)

This defect of the foreskin may be either congenital or acquired, the latter much oftener than is generally supposed. In the congenital variety the obstacle to the retraction of the prepuce is entirely confined to the mucous membrane, which is always found closely embracing the head of the penis, and is thickened, short, and unyielding from its junction with the skin backward.

Phimosis is frequently hereditary. I have operated on three children in one family all of whom were born with contracted foreskins. The evils which this imperfection occasions are numerous. Not only does it impose a difficulty in preserving a proper cleanliness of the parts by retaining the secretions of Tyson's glands and impeding the flow of the urine, but, as a consequence of this, it creates an irritation the reflex influence of which may

induce incontinence of urine, symptoms of stone in the bladder, paralysis of the lower extremities, convulsions, masturbation, priapism, etc. The contraction may interfere with sexual congress, or may complicate the treatment of gonorrhœa. I visited, in connection with Dr. John Lodge, of this city, a child who had suffered for over one year with a severe eczema, extending over the lower part of the abdomen, over the groins, and inside the thighs, and which had resisted all kinds of remedies. As the little patient had a well-marked phimosis, I performed a circumcision, which not only relieved the congenital defect, but cured in a few days the cutaneous disease. Phimosis is often the exciting cause of epileptiform attacks, a fact to which the attention of the profession has been called by Professor Sayre, and which was very well exemplified in a case which I saw in consultation with Dr. Gittings, of this city. The patient, a child, had some days as many as eight or ten convulsions. There being no other detectable source of irritation to which this condition could be referred than that arising from a long, narrow prepuce, I advised circumcision. The operation was followed by a perfect cure. Not only does this reflex irritability arising from phimosis involve all the voluntary muscles, as witnessed in general convulsions, but it occasionally selects certain groups of muscles, the spasmodic contraction of which may simulate club-foot, knee-joint disease, or even hip-joint disease.

TREATMENT.—It is not every case of congenital phimosis which demands operative interference. Where the orifice is not so small as to interfere with the free escape of the urine, even though it is too narrow to allow the glans penis to be uncovered, it is well to wait for a few months. Remarkable changes frequently occur as the development of the organ progresses, which, by enlarging the preputial opening, may render an operation entirely unnecessary.

When, however, the preputial contraction is so great as to interfere with the free escape of the urine, the sooner the defect is corrected the better. The operation may be done at any period of life from two months upward, the most important condition being always that the child shall be free from disease at the time of its performance, except such as may be the result of the phimosis.

OPERATION.—There are three operations which answer every purpose for the cure of phimosis,—*dilatation*, *circumcision*, and *incision*.

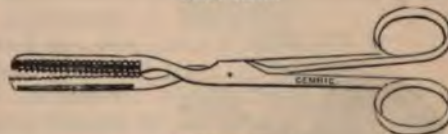
Dilatation.—When there is no excess of foreskin and the preputial opening is not extremely small, gradual dilatation will overcome the phimosis very satisfactorily.

The instrument by which this is accomplished resembles a pair of forceps (Fig. 1241), the articulation being only half an inch from the end of the blades.

The latter are to be introduced, closed, through the opening in the foreskin, and the dilatation, which at first must be moderate, is maintained by pressing the handles of the forceps together until some uneasiness is manifested by the patient, when they may be fixed by the catch and allowed to remain *in situ* for twenty minutes. This should be repeated every day or two until the prepuce can be easily retracted behind the glans,—the work, generally, of five or six days. This plan is greatly preferable to forcible dilatation and rupture of the mucous membrane, which is not unattended with danger, particularly with feeble children, by causing diffuse inflammation of the integument of the penis.

Circumcision is an old religious rite established among the Hebrews by Divine command, which doubtless, like many other parts of the ceremonial law, had a hygienic value as well as a ritual significance. The operation of the priest differs materially from that of the surgeon. The former,

FIG. 1241.



Phimosis forceps.

after drawing the prepuce through a slit in a metal ring, which is used to protect the head of the penis from injury, cuts it off, and then tears with his fingers the mucous membrane, which he turns back, keeping both it and the skin behind the glans by a roll of lint. No ligatures or sutures are employed, and consequently several deaths have been known to occur from hemorrhage. Circumcision is always to be preferred when there is much redundancy of the prepuce. As the mucous membrane is frequently found adherent to the glans penis,—a condition which seems to be normal in the early months of intra-uterine life,—the two should be separated, as a preliminary measure, by introducing a probe or director through the preputial opening and passing it round the head of the organ as far back as the corona glandis. The foreskin should now be drawn forward, so that the portion which before lay over the middle of the glans penis shall be brought to its extremity, immediately in front of the latter. A pair of forceps with curved blades, the convexity being forward, is made to embrace firmly the foreskin. The blades being

FIG. 1242.



Prepuce embraced with the forceps preparatory to cutting off.

now fixed with the slide belonging to the instrument, the operator, after consigning the forceps to an assistant, seizes the free portion of the foreskin between his fingers and shaves it off with a sharp bistoury, close along the anterior surface of the forceps. (Fig. 1242.) The blades of the instrument being now disengaged from the stump of the prepuce, the latter is to be drawn back, which exposes the mucous membrane still covering the head of the penis like a hood. This is now to

be dragged forward and cut off transversely, like the foreskin, or to be slit up with a pair of scissors over the upper surface of the glans almost to the corona.

If there are any adhesions between the membrane and the head of the organ which have escaped the probe, they may now be broken up, after which the flaps of the mucous membrane should be rounded off with the scissors, taking care not to trench on the frænum, and their edges stitched to the integument in four or five places with the interrupted sutures, the first one being always placed at the upper angle of the incision through the mucous

FIG. 1243.



Mucous membrane slit up and one side reflected and stitched to the skin of the prepuce.

membrane. (Fig. 1243.) These sutures should be cut leaving long ends, so that they can be readily discovered when the time comes for their removal. Any vessel which continues to bleed should invariably be tied with a fine ligature, as the sutures, however placed, will not always control the hemorrhage, and the blood getting in between the mucous membrane and the skin, and even into the connective tissue beneath the latter, not only interferes with the healing, but may be followed by fatal prostration. A linen rag wet with cold water must be laid over the parts,

and kept in place in the case of children (after turning the penis up, to prevent swelling around the frænum) by applying the "square" or diaper. The dressing will require to be renewed every three or four hours, or as

often as it becomes dry. On the third or fourth day the stitches should be removed, and the water dressing continued for four or five days longer, after which the parts may be covered with a fine, soft piece of linen spread with benzoated oxide of zinc ointment.

Incision.—In cases of phimosis where there is little redundancy of the foreskin, incision will answer every purpose. The director being introduced, as in circumcision, between the glans penis and the mucous membrane, and any existing adhesions broken up, the operator introduces the probe-pointed blades of a pair of scissors between the prepuce and the glans penis, and slits up the foreskin over the dorsum as far as the corona. This incision is sometimes made by first introducing a director, along the groove of which a sharp-pointed bistoury is passed, and, after piercing the integument over the corona, cutting directly from behind forward. After noticing that no adhesions remain between the head of the penis and the mucous membrane, the latter should be stitched to the skin by fine sutures, the first being inserted at the upper angle of the wound, and two on each side of the longitudinal incision. (Fig. 1244.)

The subsequent dressing should be the same in all details as after circumcision. Some surgeons prefer to round off the margins of the lateral flaps before introducing the stitches, so as to get rid of what they fancifully call the dog-eared appearance of the prepuce, which results from a simple longitudinal incision; but this is unnecessary, as nature will in time do the same thing perfectly. There are several other methods of operating for phimosis, as by dressing forceps or dilators introduced through the preputial orifice, and then rupturing the contracted mucous membrane either by forcible dilatation or by sudden withdrawal of the widely-expanded blades of the instrument. These operations, recommended by Hutton and by Cruise, are not adapted to all cases, and in some utterly fail by reason of the inflammation which follows the rude tearing of the mucous membrane.

Dr. Levis has devised a forceps (Fig. 1245) the blades of which, when

FIG. 1244.



Operation by incision. Skin and mucous membrane slit up and united by the interrupted suture.

FIG. 1245.



Levis's forceps for removing the contracted mucous membrane in phimosis.

closed, resemble the threads of a screw, and can be separated or opened at pleasure by a screw placed near the articulation of the blades.

The object of the operator is to remove the contracted or unyielding mucous membrane without cutting away the skin, which is always sufficiently elastic and not at fault in phimosis. The blades are introduced closed into the opening of the prepuce, and then expanded by the screw at the upper end of the instrument. When traction is made, the sharp thread on the blades clings to the mucous membrane, and admits of its being drawn out and incised.

In children of hemorrhagic tendencies, no operation except that of gradual dilatation should be undertaken.

ACQUIRED PHIMOSIS arises from inflammatory thickening of the preputial

orifice, occasioned by gonorrhea, chancre, or any cause which keeps up irritation of either the foreskin or the glans penis.

TREATMENT.—Frequently, phimosis originating in the above causes disappears spontaneously without any operation, the plastic deposits becoming absorbed after the subsidence of the inflammation. In acute cases our remedies should be addressed to the parts with a view to secure such a termination by removing the cause. Injections can be made either of warm water, for the purpose of dislodging glandular secretions, or of medicated liquids, when gonorrhœa or venereal sores are present. No operation should be done during an acute inflammatory attack, as the patient would be exposed to risks of erysipelas, ulceration, and sloughing.

In most instances of acquired phimosis the operation by dorsal incision is all that is required, stitching together the edges of the skin and mucous membrane, as in the operation for congenital phimosis. When there is a great thickening, as is often the case, at the lower semi-circumference of the prepuce, from the effects of old venereal sores, circumcision will yield the most satisfactory results. Occasionally it happens that a concealed chancre exists, which cannot be successfully treated until it is fairly exposed: under these circumstances an operation becomes imperative. If the syphilitic sore is a chancre, the wound is liable to become inoculated. To prevent this occurrence, Dr. Lowman, of New York, is in the habit of injecting beneath the foreskin and the head of the penis a forty-grain solution of nitrate of silver before operating, neutralizing the effects of the caustic afterwards by a second injection of a solution of common salt. The prepuce is then slit open and the edges of the incision cauterized with nitric acid. This practice, omitting only the salt injection, has long been in use in Philadelphia.

Paraphimosis (*παρά*, "amiss," and *φίμω*, "I bind") is the condition which results from the retraction of a preternaturally narrow foreskin behind the corona glandis, and is, consequently, the opposite of phimosis. The contraction which follows the new position of the preputial orifice causes a deep groove behind the head of the penis, which, in consequence of the rapid swelling, is lodged between the two swollen collars of the foreskin. (Fig. 1246.)

If not soon relieved, the contraction occasions much swelling and uneasiness, with pain and inflammation, in the strangulated glans, and has in some instances been followed by mortification of the head of the organ.

FIG. 1246.



Paraphimosis.

Paraphimosis is generally met with among boys or young men, who are not aware of the inconveniences resulting from an abnormally narrow prepuce. The habit so often indulged in by lads of slipping a ring or tying a string around the penis should not be forgotten by the operator, as the appearance of the organ in cases of constriction produced in this manner is not unlike that which it presents in paraphimosis from natural causes.

TREATMENT.—The reduction of the foreskin in paraphimosis may be effected by *manual pressure conjoined with traction*, and by *incision*.

There are two methods usually practiced for reduction by the former plan, neither of which, however, exactly fulfills the requisitions necessary to command success. These are, first, to press the blood out of the engorged gland; secondly, to roll the prepuce forward over the head of the penis. In the methods in common practice (one of which is represented in Fig. 1247), either the locked index and middle fingers of both hands embrace the penis behind the constriction, while the two thumbs are placed against the glans penis, or the organ is encircled by the index finger and thumb of one hand, while the glans penis is pressed with the index finger and thumb of the other.

By either method the forces of the two hands tend to neutralize each other; for the more strongly the head is pressed upon to empty its vessels and force

FIG. 1247.



Phillips's method of reducing a paraphimosis.

FIG. 1248.



Author's method of reducing paraphimosis.

it back, the more tightly must the body of the organ be compressed to resist, and of course to prevent the reflux of blood, thus adding a stricture to the one already existing. A more rational plan is, after etherizing the patient, to grasp the head of the penis in the palm of the hand and compress it strongly for some time (Fig. 1248), until the cells of its spongy tissue are measurably emptied, when the prepuce can be rolled forward, and the reduction effected with the same hand, assisted, if necessary, with the fingers of the other, pressing the partially flaccid glans back.

As adjuvants to manual reduction, the local application of ice, punctures, and acupressure by elastic bands are sometimes employed. But, as a rule, if the surgeon fails to effect the reposition of the foreskin, it is best to proceed at once to the operation. This consists in insinuating beneath the stricture the point of a curved, sharp-pointed bistoury, with its back towards the dorsum of the organ, while the glans penis is depressed between the thumb and the index finger, and dividing freely the constricting band from behind forward (Fig. 1249), when the prepuce can be replaced over the head of the penis without difficulty.

The seat of the stricture must always be sought for behind the first collar of the swollen foreskin. To prevent a recurrence of the accident, the operation for phimosis should be advised after the parts have returned to their natural condition. The only dressing required after the division of the stricture is one of water containing a few drops of laudanum.

FIG. 1249.



Dividing the stricture in paraphimosis.

Short Frænum Præputii.—Occasionally we meet with cases in which the frænum is preternaturally short, so that during erection the band is severely and painfully stretched, and may, in addition to causing some degree of incurvation of the organ, also become fissured or torn. When the latter occurs, the accident is often followed by severe hemorrhage, and may leave a troublesome ulcer, which opens at every act of coitus. The remedy con-

sists in detaching the frænum from the under surface of the glans, sliding it back, and retaining it in its new position by one or two sutures.

Absence of the Frænum.—The evil of a short frænum is scarcely greater than that of the condition in which the bridle has been destroyed by a chancre and the foreskin is allowed an unlimited retraction. Persons who have suffered in this manner complain of a peculiar distress, and also of an annoying sense of incapacity for satisfactorily executing the sexual act. There is reason to believe that the inconvenience and disqualification complained of are not altogether imaginary. Operations about the sexual organs call into the highest requisition the æsthetics of surgery; and hence, whether the effects of the condition under consideration are imaginary or not, it is proper to repair the defect as far as possible. This is to be attempted by freshening the centre of the foreskin on the under surface of the organ, and also that part of the penis which answers to the natural position of the frænum, and uniting the two by two fine stitches, one on either side, or by one very delicate pin and thread, counteracting erections by the use of cold, bromide of potassium, and suppositories of opium and camphor.

Epithelioma of the Prepuce occurs generally in old persons, or at least in those who have passed middle life. It commences as a tubercle, crack, or wart, and slowly extends its area of infiltration to the surrounding structures.

FIG. 1250.



Epithelioma of the prepuce.

An ulcer soon forms, which after a time throws out a cauliflower growth of granulations, from which flows a thin sanious discharge, highly offensive, and which irritates the adjoining parts with which it comes in contact. (Fig. 1250.) The disease gradually extends, destroying by small installments the glans penis, the prepuce, and the body of the organ, and involving finally the lymphatic glands of the groin. The disease is rarely of rapid progress, sometimes lasting six or eight years, but finally wearing the patient out by pain, blood-poisoning, and constitutional exhaustion.

Phimosis is thought by some writers to be actively concerned in the production of carcinoma of the penis. The data for such a conclusion are very meagre. I have seen many cases of the disease in which there was no previous history of any such condition of the foreskin. The supposed partial exemption from this disease of the Hebrews, who still maintain the rite of circumcision, has been adduced by Travers in support of this opinion; but I am not aware that any comparisons have been drawn between the numerical strength of the Jews and that of all other persons which would render such a supposition probable.

Scirrhus is rarely seen in the penis, and, when present, commences, it is said, behind the corona glandis, most probably in the glands of Tyson, situated in this locality. I have never seen an instance of the disease.

TREATMENT.—When epithelial disease begins on the prepuce, and is easily recognized, it may suffice to remove the foreskin, observing to extend the incision sufficiently far into the sound skin to include (so far as can be determined) all the diseased tissue. If, however, as is usually the case, the affection has existed for a considerable length of time, and particularly when the ulceration involves the glans penis, no operation short of amputation will be of any value. In this operation the principal part of the organ should be sacrificed, even though the disease may not have extended farther than the glans or corona of the penis.

Amputation of the penis is a simple operation, and can be performed either with the knife or with the *écraseur*. If the knife is employed, the circulation

can be controlled during the operation by an assistant grasping the organ above and below, close to the pubes, between the thumb and index finger, or by surrounding it with a narrow cord of rubber; or, finally, by an instrument (Fig. 1251) the curved blades of which can be screwed together with

FIG. 1251.



Clamp forceps for compressing the penis in amputation.

sufficient force to compress the vessels. The hemorrhage, however, is rarely very profuse, being a free oozing rather than an arterial jet. After providing by one of the above measures for the bleeding, the operator, covering the ulcerated portion by a strip of bandage, grasps the penis with one hand, at the same time drawing the integument a little forward with the other hand, when the organ is severed by a single stroke of the knife. When the amputation is done near to the pubes, the stump is liable to retract, and may become buried beneath the pubes; though, by a little manipulation, it can usually be made to protrude. Yet, that there may be no embarrassment, a strong ligature may be passed by a needle through the fibrous sheaths of the cavernous bodies and tied in a loose loop, which will place the stump under perfect command. The vessels which may require a thread are the dorsal, the two cavernous arteries, and the artery of the pectiniform septum. Several suggestions have been made with reference to covering the stump and preventing the contraction of the orifice of the urethra. The tendency of the latter to become so narrow as seriously to obstruct the escape of the urine is a matter of common observation.

To resist this, Mr. Hilton, instead of cutting the cavernous and spongy bodies on the same level, divides the latter a little in advance of the former, afterwards slitting up the urethra and suturing its sides to the integument. This is a very satisfactory operation, though it is vain to expect that the flaps will long remain in the position in which they are stitched.

After the amputation the parts require to be covered with lint or two or three thicknesses of old linen, and kept wet with cold water, or they may be dressed with a piece of linen moistened with carbolic acid and sweet oil. The utmost attention to cleanliness must be rigidly enforced, in order that the discharge from the wound shall not be allowed to remain in contact with the spongy structure of the cavernous and spongy bodies,—surfaces admirably adapted to receive and transmit to the general system any poisonous products which might result from decomposing matters. A solution of permanganate of potash thrown into the recesses of the stump with a syringe will be found to fulfill every indication.

To prevent the urine from running over the wound, a short, straight, metallic tube, or a female catheter, can be introduced into the bladder, corked and secured in the ordinary manner, and be allowed to remain for two or three days. It should then be removed, cleansed, and, if causing no irritation, be replaced. I have sometimes, instead of carrying the instrument into the bladder, confined it in the urethra alone; and, although some urine may pass round the catheter, the largest amount will be discharged through its canal.

In the course of seven or eight days, when the parts about the stump begin to become fixed and the raw surface commences to granulate, the instrument may be laid aside. After recovery, the patient must be furnished with a bougie and instructed in its use, so that he can at intervals of three or four

days, by inserting the instrument a little distance into the urethra, prevent any serious contraction of the orifice. In no other way is it practicable to surmount this difficulty. As it is impossible, after the amputation of the organ, for the person to project the stream of urine any distance from the opening, it is liable to bespatter the clothing and fall at the feet. To provide for this disability, a little metallic or rubber tube (Fig. 1252) can be used, which, fitting over the parts, will receive the flow and conduct it away from the person.

FIG. 1252.



Urinal for use
after amputa-
tion of the pe-
nis.

If the *écraseur* is employed for the amputation, the skin should be drawn forward some distance before the chain of the instrument is tightened, after which the screw may be rapidly turned and the organ crushed off in the space of a minute. Or it may be done with more deliberation, occupying for the purpose a period of ten or fifteen minutes. It is a matter of indifference which plan is pursued, as the bleeding will be about the same in both cases. The most bloodless operation is that by the galvano-cautery, which is the one preferred by some surgeons.

There are cases of cancer of the penis in which the disease has extended far up towards the pubes, and where, in order to get rid of a foul, offensive sore and to palliate for a time the severity of the pain, the surgeon will be justified in removing the organ, even up to the crura. In such a case it is necessary, after the removal of the hair, to place the patient in the lithotomy posture and with the limbs widely separated. Two curvilinear incisions are then made, beginning at the middle line over the front of the pubes, passing down one on each side of the penis, and terminating one inch below the peno-scrotal juncture. By dissecting these flaps of integument back a little distance the corpora cavernosa and corpus spongiosum will be brought into view. A long acupressure-pin being now passed through the former from side to side, so as to prevent retraction, the organ can be severed immediately in front, after which the vessels are to be secured. In order to open as free a passage as possible for the urine, a grooved staff is next introduced into the urethra and carried into the bladder, when the operator makes a free incision through the *raphé* of the perineum, dissecting down until the bulb of the corpus spongiosum is reached. One inch forward, separate the latter from the cavernous bodies, and, after slitting up the urethra longitudinally, stitch it to the sides and the anterior angle of the perineal wound. This will secure an uninterrupted outlet for the urine. If there is no bleeding, the long acupressure-pin commanding the cavernous bodies should now be removed, a small drainage-tube introduced, the anterior wound closed over the stump, and the staff removed from the bladder.

Even when the inguinal glands are enlarged, and where nothing more than palliation can be promised, so great is the comfort experienced by a patient in being temporarily freed from an offensive disease like the one under consideration, that I do not hesitate to advise an operation. The prepuce may occasionally be the seat of benign growths, as sebaceous, vascular, fibrous, and adipose tumors, which are amenable to the same plans of treatment as would be adapted to similar tumors situated in other parts of the body.

Inflammation of the Penis may arise directly from injury, or indirectly from the extension of an irritation from a virulent ulcer, as a phagedenic chancre or a severe urethritis. In whatever manner it originates, there is great heat, with swelling, induration, and pain of the organ, the suffering being much aggravated by erections.

When the patient is vigorous and not reduced from the effects of a sloughing chancre, a few leeches applied along the course of the dorsal artery of the penis will afford marked relief. The organ must be swathed with hot anodyne

fomentations, and the erections controlled by the free use of bromide of potassium and suppositories of camphor, opium, and lupulin. As the passage of the urine often increases the suffering, it must be rendered as bland as possible by giving freely alkaline diluents. There is a chronic form of inflammation which may commence as such, or may succeed an acute attack, and which is very local or circumscribed in extent, occupying some part of the cavernous body. The transudation filling the cells of the erectile tissue destroys the extensibility of that portion of the corpus cavernosum involved, while the other remains unimpaired, and necessarily, in the turgid condition, turns the organ towards the diseased side. These inflammatory deposits may extend, or they may disappear at one point and appear at another. When arising from syphilitic causes (which I am confident is sometimes the case), the disease is amenable to large doses of iodide of potassium and tonics, under the influence of which remedies the erectibility of the organ, when lost, may be restored. When no syphilitic history can be made out, iodide of iron and cod-liver oil are worthy of a prolonged trial.

Gangrene of the penis may attack either the integument or the organ itself. It may have an inflammatory or an obstructive origin. As a result of the former, it is occasionally seen accompanying destructive ulcerations, such as sloughing chancre, or after operations for phimosis in children of irritable constitution. When limited to the integument the inflammation presents the character of erysipelas. It is announced by great swelling, tenderness, and a dusky-red color of the skin, and, if not arrested, is soon followed by a dark-lead or purple discoloration, quickly changing to black. The general system sympathizes with the local disorder. The pulse becomes frequent and feeble, the tongue dry and covered with a brown coat, and there are headache, loss of appetite, and exhaustion. To prevent, or at least to limit, the sloughing, it is important to unload the cellular tissue of the integument of its infiltration, by making early two or three incisions into its structure, as is usually practiced in phlegmonous erysipelas. After this is done, the ordinary hot-water dressing or flaxseed poultices will constitute the best local application. The general system must be supported by nourishment, stimulants, and tonics, and nervous restlessness is to be allayed by anodynes.

The obstructive variety of gangrene which is met with in the penis may arise from either a mechanical or a pathological cause.

Mechanical causes.—Boys have a mischievous habit of slipping rings over the organ, or surrounding it with a cord, while in a flaccid state. During erection the irritation caused by the compression provokes an inflammatory swelling, during which the constricting body becomes buried in the tissues and passes more and more out of sight, until the vitality of the distal part is either lost or seriously imperiled. Many curious cases of this nature have been recorded. A boy among the out-patients of St. Bartholomew's Hospital complained of having lost all sensation in the penis, and had, in addition, a urinary fistula. The organ was threatened with mortification. On examination there was found deeply buried in the organ a string, which some time previously had been tied around its base, and which had gradually cut its way through the parts. All the nerves and vessels had been severed.* In another case,—a man, fifty years old, who was brought before the Medical Society of the Hospital of Paris,—seven iron rings were found over the penis towards the pubes. Gangrene was impending in this case, when the rings were cut away and the penis saved.† Guillot relates a case in which a gold wedding-ring was used in the same manner. A case is also told of a wet-nurse who wound a long hair from her head five times round the root of the penis of a Jewish boy four weeks old, and each time tied on it a firm knot. The cause of the child's suffering was with difficulty ascertained, and the constriction removed in time to prevent mortification.‡ The con-

* Half-Yearly Abstract of Medical Sciences, vol. xxv. p. 180.

† Lancet, April 4, 1868, p. 440.

‡ Dublin Medical Journal, vol. i. p. 246.

striction of a tight paraphimosis may be sufficient to interrupt seriously the circulation in the glans penis and to endanger its life. The sign which indicates a strangulation of the penis from the causes above enumerated is the presence of a narrow sulcus at some portion of the organ. The remedy consists in etherizing the patient, dilating the fissure, and dividing the constricting body. When the latter is composed of metal, it will require to be cut with the bone pliers.

Pathological or idiopathic gangrene, a subject which has particularly engaged the attention of Dumarquay, is an uncommon occurrence. My own knowledge of the disease is confined to a single case, which occurred in the surgical ward of the Philadelphia Hospital. The patient was an aged man, and one whose constitution had been seriously shattered. The discoloration commenced without known cause, and was at first characterized by deep purple lines, answering to the branches of the great dorsal vein; this was gradually followed by discoloration of the integument, and later by a similar condition, with ulceration, of the glans penis, gradually, but slowly, creeping upward, until a large portion of the organ was destroyed, and eventually the patient succumbed. The cause of the sloughing in this case was embolism of the dorsal artery. The disease has been observed to follow typhoid fever and other exhausting affections; and, as we not unfrequently witness obstruction of the veins of the legs and mortification of the feet from blood-changes incident to the former disease, it is to be presumed that the true cause of the gangrene under consideration consists in phlebitis and embolism. Where the vessels are thus occluded, treatment can be of little avail, and the efforts of the surgeon must be directed to deodorizing and disinfecting the parts by antiseptic washes, controlling hemorrhage, should it occur, by the persulphate of iron, and sustaining the strength with nourishment, stimulants, and tonics.

Fracture of the Penis.—This term is used to designate an injury which consists in a laceration of the dense fibrous cylinders which inclose the spongy tissue of the corpora cavernosa. The laceration can occur only when the organ is in a state of extreme erection. While in this condition, it has been broken by being suddenly and forcibly bent, either accidentally in coition or maliciously by the hand of another. The laceration is known by a sense of something having been broken, intense pain, and a sudden subsidence of the tumescence of the organ, accompanied by nausea, and for a short time by general prostration. In one case communicated to me, the injury occurred by the patient's suddenly rising from bed and falling against the bed-post while the penis was in a state of priapism. The rupture is followed by a large extravasation of blood into the spongy tissue of the corpora cavernosa and great swelling of the penis, which may even extend to the scrotum. If the injury is confined to one of the cavernous bodies, the organ will be turned somewhat towards the side opposite that injured. The sanguineous extravasation will be followed by inflammation and the transudation of lymph, which, becoming incorporated with the blood, forms a hard mass. Most of this will in time become absorbed, though usually there remains an induration, which, being altogether unlike the spongy tissue in the midst of which it lies, gives rise to a lateral or upward curvature in erection, according as one or both cavernous bodies have participated in the accident. This condition seriously interferes with the sexual act. In some instances the organ is permanently rendered *hors du combat*. Even death has been known to follow this injury, in consequence of blood-poisoning.

The *treatment* must be directed towards averting the internal extravasation of blood, combating inflammation, and securing the absorption of inflammatory and other products. The first two objects are best attained by surrounding the penis with cloths soaked in ice-water, and by compression with strips of muslin; and the third by stimulating friction, and especially by well-graduated pressure. If the hemorrhage is so profuse as to endanger

the vitality of the organ and induce mortification, an incision should be made into the spongy tissue, and the blood allowed to escape. During the cure, something may be done to prevent subsequent distortion by encircling the organ with a plaster roller, which, after the bandage becomes hard, must be slit up along the dorsum of the penis, and can be slipped off and on over the dressing at pleasure. In this way the part may be kept in a straight position.

Curvature of the Penis.—In cases less severe than those just enumerated, the injury may amount only to a limited extravasation of blood into the erectile tissue of one of the corpora cavernosa, which is followed by an equally limited inflammation and transudation of lymph. This becomes organized into a dense mass of connective tissue, which renders this part of the penis inextensible. The effect of an erection is to cause a *bend* or angle in the organ towards the diseased side, which is sufficient to defeat sexual intercourse. The consciousness of such a disability is often sufficient to induce extreme despair.

This condition may to a considerable extent be remedied by an operation devised by Physick, which consists in dividing the integument and retracting its edges sufficiently wide apart to admit of a wedge-shaped piece being excised from the sound corpus cavernosum, directly opposite the induration, and closing up the wound in the same by deep interrupted sutures, over which the integument is to be brought together and retained by a few stitches. The organ requires to be supported in a leather or plaster splint, and erections must be subdued by cold water and anodyne suppositories. The stitches should be allowed to remain as long as they retain their hold and do not become loose.

Luxation.—The connection between the glans penis, the rounded extremity of the cavernous bodies, and the corpus spongiosum is such that one might anticipate its displacement under the application of some inordinate force. A preparation was at one time in my possession which appeared to verify the possibility of this accident; but I have reason to believe that the dislocation was the work of the knife rather than an accident.

Nélaton has furnished an example of a backward luxation of the cavernous bodies from the spongy body, which was reduced by drawing the former forward into place.

Calcification.—Hard, gristly masses of fibrous tissue, which in time undergo calcareous transformation, are occasionally observed in the structure of the corpora cavernosa. These may occupy any or a great part of these bodies. They may be felt on the pectiniform septum, and I have seen them near the corona. They are, so far as my observation extends, confined to persons beyond mature life, or at least at that age when atheromatous changes are common in the vascular system. The presence of these masses gives rise to such alterations in the form of the penis, when erect, as to interfere with or entirely prevent sexual intercourse. The only remedy, in cases where the induration is limited, is excision.

Priapism is a morbid erection of long continuance, unattended by any pleasurable sensation. It is generally dependent on some irritation acting on the brain or spinal cord. Thus, it has been frequently witnessed after sanguineous extravasation in the cerebellum, fractures of the spine, and severe concussions of the spinal cord. In a lad who was under my care and had been thrown under a street-car, receiving, in addition to several fractures of the long bones, a fracture in the upper dorsal region, followed by paraplegia, priapism continued unremittingly for three months. This affection is sometimes produced in children by a narrow prepuce, and may also follow certain irritations acting on the neck of the bladder, as that from cantharides.

Priapism is sometimes witnessed in persons who die from strangulation, as in hanging.

TREATMENT.—When priapism is the result of lesions in the brain or the cord, little can be done to relieve the patient, though it usually disappears as the central improvement advances. When it arises from wounds or diseases of the penis, it is best controlled by the local application of cold, suppositories of opium, camphor, and lupulin, and the free use of bromide of potassium.

Though sexual intercourse is possible in this state of the organ, it is unattended with any venereal desire, and rarely accompanied by pleasure or seminal ejaculation.

Warts, though in a large majority of instances having a venereal origin, occasionally occur from a neglect to remove the accumulation which takes place beneath a tight foreskin. The seat of these growths is on the glans penis and around the margin of the preputial opening. (Fig. 1253.) As they thrive in a moist soil, it is important to apply some good absorbent and astringent remedy, the best being a mixture of calomel and gallic acid (calomel three parts, gallic acid one part), at the same time interposing a little lint between the foreskin and the glans penis. As the vitality of these warts is very low, they will frequently shrivel up and disappear under the influence of this powder. When this is not the case, they may be divested of all moisture, and touched once every three or four days with a little chromic acid, and afterwards covered with absorbent cotton. Finally, if these means are not successful, we have a certain remedy in clipping them off on a level with the surface on which they grow, and, after cessation of the bleeding, which is generally profuse for a time, touching the base of each one with a crayon of nitrate of silver, or with a little nitric acid.

FIG. 1253.



Warts on the penis.

Wounds of the Penis may be either accidental, self-inflicted, or criminal.

Accidental wounds of the penis are not very often seen, except as shot injuries, and as such they constitute comparatively a very small number. Only 309 cases of this class of injuries were reported during the late American war, 41 of which, or 13.26 per cent., proved fatal in consequence of the accompanying complications. In several instances balls were extracted from the penis shortly after their entrance; but they may become harmlessly encysted. Eve has recorded an instance of a ball lodging in the prostatic portion of the urethra, from which it was extracted by perineal section.

Shot wounds of the penis, when they involve the urethra, constitute a troublesome complication, as the fistulae which form are very difficult to manage.

When a shot missile passes through or lodges in the corpus cavernosum, it is followed by considerable extravasation of blood into the contiguous portions of the spongy tissue of the organ; but there is little external hemorrhage. The separation of the slough and the repair by granulation leave a cicatricial hardness, which materially interferes with the distensibility of this portion of the organ, and in erections is followed by deformity.

The treatment of shot wounds in the penis consists in the removal of the foreign body, if any is present. The dilatability of the spongy tissue of the organ admits of an easy exploration and extraction of the ball. The organ is afterwards to be kept enveloped in lint or linen rags wet with cold water.

Incised wounds of the penis, though sometimes accidental occurrences, are more commonly the work of insanity, jealousy, or malice. Bertherand

mentions the case of a French soldier in Algiers, whose penis and scrotum were bitten by a dog, and Stromeyer relates another, also of a soldier, in whom almost the entire integument was torn off by the teeth of a horse while the man was unclothed and in the act of washing his body. A not altogether dissimilar case is that of a patient of Mr. Hilton, admitted into Guy's Hospital, in whom the penis had been bitten by a stallion.

A man was brought into the Pennsylvania Hospital with a deep, lacerated wound of the penis, which he confessed had been inflicted by the teeth of a negro during a beastly and unnatural use of the organ. Otis records two attempts made by insane soldiers to cut off the genital organs, in both of which cases severe wounds were inflicted. The same author mentions the case of another soldier who had the penis cut off in a broil, close to the pubes. Numerous instances might be adduced of these mutilations from the records of insane hospitals.

Self-mutilation from motives of a religious character has been practiced by a small body of fanatics in Russia. These people ground the authority of their sect on the 12th verse of the 19th chapter of St. Matthew's Gospel. Singular though it may seem, the followers of this creed became sufficiently numerous to demand for their suppression the strong arm of governmental interposition. Pirogoff speaks of having examined a number of these persons in the prisons of Russia, in whom the genitals were removed close to the body.

TREATMENT.—The indications in the treatment of incised injuries of the penis are, *first*, the arrest of hemorrhage; *second*, the approximation of the edges of the wound; and, *third*, the control of erections. The first indication is often best fulfilled by carrying into effect the second,—that is to say, the bleeding may require nothing more for its control than pressure produced by bringing the sides of the wound together. Should this not be sufficient to staunch the flow, the vessel or vessels must be sought for in the wound and tied. If this is found impracticable, it will be necessary, after inserting a sufficient number of deep sutures, to introduce a large-sized metallic catheter into the bladder, and, after firmly bandaging the organ, to keep the dressing constantly wet with cold water. In an obstinate case of bleeding, other means having failed to arrest the flow, an acupressure-pin might be passed over the dorsal artery of the penis, immediately in front of the pubes, or the pin might be passed beneath the vessel and the compression applied by a thread passed over its end as in forming a twisted suture.

The extent to which the penis may be divided and yet union take place is a question which has not been satisfactorily determined. Boyer and others have stated that if the corpora cavernosa be severed to the extent of two-thirds of their thickness reunion need not be expected, and that it will be better, under such circumstances, to amputate the part. Such an opinion requires confirmation before it should be accepted as an established surgical maxim. I should make an effort to secure union as long as any continuity of tissue remained. The great vascularity of the organ and the firm sheaths of the cavernous bodies, well calculated to retain sutures and preserve a due apposition, are conditions which render success at least possible. The sutures in such a case ought to be numerous.

Wounds of the Corpus Spongiosum and Urethra have the serious disadvantage of being exposed to the contact of the urine, and, consequently, have a strong tendency to the formation of a urinary fistula. A catheter in such cases must be immediately introduced and retained in the bladder, so as to keep the urine from the wound, the edges of which should be neatly approximated and retained by numerous sutures, introduced as deep as the submucous tissue of the urethra. Though the objections to retaining an instrument a long time in the bladder are substantially just, yet in a case of this nature it is the lesser evil of the two, and it should not be withdrawn for at least six days, or until the union of the wound is tolerably well assured. The water

dressing, containing a little laudanum, constitutes the best application in all wounds of this organ. One of the difficulties to be encountered in injuries of this nature is troublesome and frequent erection, which demands for its relief the local use of cold, with full doses of bromide of potassium, and suppositories of opium, camphor, and lupulin.

Laceration of the Urethra.—This is by no means an uncommon accident, and may be produced in various ways,—by kicks, falls, or blows on the perineum; by straining efforts to pass the urine through a tight stricture; by a spiculum of bone in fractures of the pelvis; and even in coition. Laceration may also be produced by causes acting from within, as by the impaction of a stone which is too large to pass through the urethral canal, and by the maladroit use of instruments, as the catheter or the bougie.

The degree of laceration varies much in different cases. It may be a slit, a round or oval opening, involving only a small part of the circumference of the canal, or the urethra may be torn completely across.

The location of the laceration may be in the penile or the perineal portions of the urethra. The danger of these injuries is greatest when the perineal portions of the tube are involved, as the complex arrangement and the continuity of the perineal and pelvic fasciæ exercise great influence on the course and disposition of urinary extravasation.

But, while this is true with regard to the life-risks, it does not imply that the difficulty of effecting a cure is greater in this division of the urethra than in the penile portion. On the contrary, the converse is true. Lacerations in the penile portion are less amenable to treatment than those in the perineal division of the canal, chiefly because the latter is exempt from the disturbing influence of erections.

The injury at first may be readily overlooked, but should always be suspected when succeeding a sufficient injury there are experienced pains in the course of the canal, hemorrhage, and a frequent desire to urinate, the effort to accomplish this being usually fruitless. The character of the accident will become more evident if, in order to relieve the vesical tenesmus, an attempt is made to introduce a catheter into the bladder. The instrument becomes arrested in the canal at the seat of rupture, or it passes through the opening and takes a direction different from that towards the bladder, imparting to the fingers a peculiar sensation very unlike that produced by a sound urethra.

A few hours, however, are sufficient to remove all uncertainty in regard to the nature of the injury. The external parts, though unbroken, begin to assume a dark-purple hue in consequence of the extravasation of blood, and on emptying the bladder, either voluntarily or spasmodically, the urine escapes through the laceration into the surrounding parts, and gives rise to increased swelling. This secretion, acting as a violent irritant to the tissues with which it comes in contact, sets up an intense inflammation, which, unless its nature is promptly recognized and the infiltration evacuated, will be followed by extensive suppuration and sloughing; nor is the irritation limited to the structures adjacent to the urethra; it extends to the general system, causing severe rigors, marked febrile excitement, thirst, restlessness, extreme prostration, and delirium. The position and limitations of the local swelling are determined by anatomical peculiarities of structure. When the perineal part of the urethra has been lacerated, the swelling and discoloration will be confined to the scrotum beneath the dartos muscle and to the under part of the penis and the lower part of the abdomen, never occurring on the inner side of the thigh, or around or behind the rectum, so long as the attachments of the middle perineal fascia and the fascia itself laterally and posteriorly remain intact.

TREATMENT.—If called immediately on the reception of a severe contusion leading to the supposition that the urethra may be lacerated, the surgeon should at once proceed to introduce a catheter into the bladder, in order to

avoid the risks of infiltration. This instrument may be either metal or gum, preferably the latter, and should be of medium size. A small catheter is passed with much greater difficulty in a case of this kind, and is much more likely to get off the track, than a large one. A catheter of good size, by unfolding the plications of the urethra, tends also to prevent the urine from escaping between the instrument and the walls of the canal. The sooner, too, the attempt is made to reach the bladder, the less difficulty will be encountered, as the swelling which succeeds the injury offers a serious obstruction to the operation.

To reach the bladder, after a laceration of the urethra, safely and quickly and by gentleness and address, before urination occurs, is a most important achievement. Though the difficulties of safely passing the laceration and reaching the bladder are in many instances very great and perplexing, every possible resource should be brought into requisition before abandoning the operation as impracticable. The obstacle to introducing the instrument is presented not only by the inflammatory swelling around the canal, but also by the particular direction in which the laceration runs. In longitudinal rents a patient and dexterous hand will generally succeed; but in those which are transverse, especially if complete (entirely severing the continuity of the canal), the most exceptional skill may be found unequal to the task.

The conditions in which the introduction of the catheter is useless, at least in the early history of laceration, are the following: first, when urinary infiltration has taken place; second, when, notwithstanding the instrument has been placed in the bladder, the water is found to pass between its sides and the wall of the urethra. Under these circumstances the catheter not only fails to accomplish the object of its use,—that of protecting the extra-urethral tissues from urinary infiltration,—but also causes additional irritation to the parts.

During the presence of the catheter in the bladder, its extremity should be corked, and the urine allowed to escape at convenient intervals of one, two, or three hours, unless it is discovered that a certain degree of uneasiness is experienced by the patient whenever a small accumulation takes place in the viscus, when it will be better to leave the tube open, so that the water may escape as soon as it enters the bladder, and thus prevent any spasmodic expulsion of its contents.

Presuming, then, that the catheter has been successfully introduced, another important question arises, as to the length of time which it is proper to retain the instrument in the bladder. I may say that no certain period can be fixed; the whole question must be determined by the tolerance of the parts and by the location of the laceration. When the latter is in that part of the urethra in front of the scrotum, I believe that after thirty-six hours, or as soon as the risk of involuntary or spasmodic expulsion of the urine is over, and the vesical irritation attending the injury has subsided so that the patient possesses a reasonable command over the bladder, it is better not to wear a catheter at all. But it should be used whenever the necessity for evacuating the bladder arises, or, what is better, at such regular intervals as experience shows the urine can be comfortably retained. When, however, the deeper parts of the urethra are torn and the difficulties of introduction have been considerable, it is better to allow the instrument to remain five or six days without being withdrawn, unless it creates a degree of irritation which renders its presence in the bladder harmful. Some, indeed, have advocated its retention until complete restoration of the lesion. I do not concur in the propriety of such a practice, however, believing that its protracted presence is not only inimical to cicatrization, but also tends to beget an irritable and, consequently, a non-retentive bladder. I have seen a catheter worn continuously for eight months, only being removed for the purpose of cleaning once every few days, and yet without success, the opening in the urethra refusing to heal. I directed the patient to cease wearing the instrument, and taught him how to introduce it himself, in order that the urine might be

drawn a certain number of times in the twenty-four hours. In three weeks he was well.

Catheters, when long retained in the bladder, become encrusted with the salts of the urine, and from this cause give rise to vesical irritation and tenesmus. A gum instrument is rendered in a few days both unfit and unsafe for use. The main objection to the withdrawal of the catheter, that its removal and subsequent reintroduction will probably break up any repair which may have begun and leave the patient again exposed to urinary infiltration, is not altogether without force. Yet, if the instrument becomes a source of uneasiness to the patient, the other horn of the dilemma is presented,—that of tenesmus and irritation, which may induce the same evil. The danger anticipated by the advocates for prolonged instrumental retention is not likely to follow the withdrawal, but rather the act of replacing the catheter. The latter operation, however, may be much simplified and made safer by introducing a filiform guide through the catheter before withdrawing the latter, and allowing it to remain as a guide over which the instrument can be passed. This device, well known to surgeons, I have frequently employed with complete success, when I felt confident that without it I should not only have encountered difficulty, but should probably have inflicted some injury upon the lacerated part.

The catheter, after its second introduction, should not be allowed to remain as long as in the first use of the instrument, unless its presence creates no uneasiness, when there can be no objection to prolonging its stay in the bladder. The object should be to shorten the period of its continuous use after each change or renewal of the instrument, until after eighteen or twenty days, when it should be employed only at proper intervals as a substitute for voluntary urination.

During the period of instrumental treatment, the parts should be covered with cold or hot fomentations, according as the sensations of the patient approve or disapprove. The vesical irritation must be palliated by anodyne injections of laudanum and starch-water, or by opium suppositories. In the course of from fourteen to sixteen days the lesion in the wall of the urethra will have been repaired, when the catheter may be laid aside. At one time I supposed it necessary, in order to guard against any probable reopening of the cicatrix under the distending force of the column of water, either to draw the urine or to instruct the patient to do so with a soft catheter, at stated periods in the twenty-four hours, for one week after the wearing of the catheter was deemed unnecessary. But for several years I have abandoned the practice as useless.

When, in consequence of the extent of laceration, the instrument cannot be inserted, or fails to carry away all the urine, the patient should be placed in the lithotomy position, with the limbs drawn up and widely separated. A catheter, staff, or sound should then be conducted along the urethra to the point of obstruction, and the soft parts freely divided from without inward, until the damaged part of the canal is reached and a free communication established between the urethra and the surface, through which the urine may find a ready and unembarrassed escape. If the urethra has been torn entirely across, an attempt should be made to bring the retracted ends together, not by stitching the tube in its whole circumference (this would be a fruitless task), but by introducing one or two sutures through the upper wall of its two extremities and drawing them together. This will serve to diminish the amount of cicatricial tissue necessary to fill up the gap, and materially aid in restoring the continuity of the canal. The stitching can be done over a small soft catheter, which will partially expand the sides of the urethra. This accomplished, there is, for the time, no further necessity for the catheter. The water must be allowed to flow through the wound until the latter is well filled up with granulations, when the time has come for giving form, continuity, and capacity to the urethra. A metallic bougie of moderate size should be gently passed through the

canal into the bladder, and this must be repeated every day or two, if well tolerated, and with graduated instruments of larger size. As soon as the external opening has in a good measure closed, a large catheter must be substituted for the bougie. In the use of the former the patient, if reasonably intelligent, can be readily instructed. With this instrument, at stated periods, the urine must be drawn,—the object being to divert the stream altogether from the abnormal route and to secure solid cicatrization. When this has been completed, it will long remain necessary, after all cases of urethral laceration, for the patient himself, or his medical attendant, to introduce a bougie, to prevent an obstructive contraction of the canal at the seat of injury. This tendency to stricture is always much greater in transverse than in longitudinal lesions of the urethra.

Too often the surgeon is not called, or the medical attendant fails to recognize the laceration, until the perineum and the scrotum have become distended with urine and the cellular tissue infiltrated with bloody pus and in a sloughing condition. Two or three free incisions must be made sufficiently deep and long to empty the parts of the vitiated extravasations, and through which the dead cellular tissue can be discharged. Hot-water dressings or warm poultices are next to be applied. In these cases the effects of the shock and irritation on the general system demand attention. Tonics, stimulants, and anodynes, in addition to good nourishment, are now necessary to counteract exhaustion, pain, and nervous restlessness.

Until the inflammatory swelling has subsided and the general condition of the patient improved, it is not necessary to introduce the catheter. The incisions are sufficient for the time to afford a way of escape for the urine. As soon, however, as the general and local appearances have improved, requiring usually five or six days, the time has arrived to divert the stream of urine from the incisions, in order that the urethral lesion may be repaired, when the catheter must be inserted. If this can be done without difficulty, it is an evidence that the laceration, both as regards extent and direction, is not a bad one. The instrument, in this case, may be allowed to remain for three or four days, after which, if the patient has a good control over the bladder, it may be removed, and only used at regular periods during the twenty-four hours. If, on the other hand, the catheter cannot be introduced beyond the seat of injury, or, when introduced, fails to conduct away all the urine, a part continuing to escape through the perineal incisions, then a direct communication must be made between the laceration and the perineum by a free cut. This cut can be guided by a catheter or a staff conducted along the urethra to the seat of trouble. This will allow the primary incision to heal up. The other details of treatment will be the same in all respects as those already described.

When the urethra has been perforated from within outward, as often happens in the careless use of catheters and bougies, urinary infiltration does not necessarily follow. The opening being made in a direction opposite to the course of the urine, the mucous membrane of the canal is forced over the aperture by the passage of the water, and acts as a valve to close the opening. These false passages, however, are by no means harmless, but often lay the foundation for urinary fistulæ. When they can be detected very soon after they occur, the proper course is to draw the water at regular intervals for ten or twelve days, until the damage has been repaired. The catheter used for this purpose should be a soft one, and only of medium size, so as not to distend the urethra.

If, after a laceration of the urethra, there follows a retention of urine, and it is found impossible to introduce the catheter, the proper course will be to lay open the perineum freely down to the seat of the lesion, guided by the catheter or the staff. When the vesical extremity of the torn urethra is reached, the instrument may be entered through the wound and the bladder emptied. This procedure has the advantage not only of relieving the retention, but also of providing against the evils of subsequent urinary extravasa-

tion, and of placing the parts in the most favorable position for permanent cure.

When the skill and courage for this operation are not immediately at command, the urgency of the retention may be met by aspirating the bladder above the pubes.

Urethral Fever.

All operations upon the urethra, however simple, and whether the canal is sound or diseased, are liable to be followed by a certain amount of constitutional disturbance, which has been distinguished by the term *urethral fever*. The intensity of this disturbance of the general system varies greatly in different persons. It may consist only in a slight chilliness, followed by a moderate increase of heat, with perhaps a little nausea and pain in the loins, with scarcely any acceleration of pulse, all of which passes over in an hour or two; or it may be ushered in with a violent and prolonged rigor, followed by great prostration, vomiting, headache, insatiable thirst, a high temperature, a rapid circulation, sweating, and a diminished or even suppressed urinary secretion. The chill and other symptoms sometimes recur with a certain degree of periodicity, and in this respect simulate an attack of miasmatic fever. These phenomena may ensue immediately on the withdrawal of a catheter or bougie, or after the passage of the urine, or they may not appear for several hours after, rarely after the first day. The occurrence of such a train of symptoms furnishes ground for uneasiness. We are necessarily, for a time at least, left in doubt whether the rigors, fever, and sweating may not be the result of poisoning from the introduction into the blood of septic or uræmic matters. Especially will there be reason to fear such an accident if there has been any evidence of pre-existing renal disease.

On this account every surgeon should ascertain, as far as possible, the state of the kidneys, when contemplating any important operation on the urinary organs. The records of surgery abound with fatal cases following the treatment of stricture by instrumentation; indeed, death has followed in a number of instances the simple act of introducing a catheter. In most of these fatal cases, where an examination of the internal organs has been made, there were discovered granular and other degeneration of the kidneys. Dr. Dickinson, in the first number of the London *Lancet* for March, 1873, describes a condition of renal pyæmia which is produced by the damming back of the urine, and which is characterized by emboli in the vessels of the Malpighian cones, and purulent accumulations in the intertubular connective tissue and around the walls of the veins.

The nature of urethral fever is very imperfectly understood. The fact that it is often postponed, after an operation on the urinary organs, until the urine is first passed, would seem to imply that there had been some laceration or abrasion of the mucous membrane, and that the contact of the urinary secretion with this had developed the general disturbance. But there are many instances of such attacks following the most gentle instrumentation, where it is exceedingly improbable that any such injury could have existed. Indeed, that we may have traumatic fever without any visible lesion of the structures of the canal does not admit of a doubt. The contact of an instrument with the mucous membrane may, in a subject possessing a highly irritable organization, or from a peculiarly susceptible condition of the urethral nerves, by virtue of their connection with other portions of the nervous system which are concerned in secretion and circulation, call into activity the whole group of symptoms which belong to this disorder, just as any other irritant may do.

When the fever is complicated by pyæmic symptoms, the poisoning, it is highly probable, is due to infecting organisms, introduced by a foul catheter into the bladder, and giving rise to the formation of septic products through the fermentative changes induced in the urine.

Suppression of urine not unfrequently follows operations on the urethra.

It may occur immediately after the use of an instrument, or it may appear in the course of the urethral fever. When the secretion is only diminished, as is often the case, or is retained for a longer period than is natural, there is little ground for anxiety, as this circumstance is quite common after severe operations of any kind, the kidney, in common with all the internal organs, having its function lessened by the effect of a shock. In addition to this, the customary use of opium in some of its forms, after these operations, tends to lessen the amount of urinary secretion. When, however, the suppression is complete, the danger cannot be over-estimated. In addition to the lumbar pain, vomiting, feeble pulse, and cadaveric appearance which accompany the suppression, the perspiration, breath, and alvine evacuations of the patient all emit an unpleasant urinous odor.

TREATMENT.—Many of the unfortunate sequelæ of urethral surgery may be avoided by a judicious preliminary treatment. The state of the kidneys should be carefully inquired into before any course with reference to treatment is adopted, and when disease is discovered to exist in these organs, the soundness of which is so necessary to successful instrumentation, any operation of a violent nature will be presumptuous. Not the least important among preparatory measures is *rest*. This includes freedom from all excitement of both body and mind for two or three days antecedent to the contemplated operation. The patient will do well to remain quietly in his quarters, diminish the amount of animal food, avoid all stimulants, and keep the bowels in a regular state. If the rest is much disturbed in consequence of local irritation, an anodyne draught may be taken at bedtime, preceded by a warm hip-bath.

Persons whose general health has been shattered by protracted suffering may require, in addition to the above management, the use of tonics, as iron, quinine, and an improved diet. Quinine exerts, it is thought, a very marked influence in preventing urethral fever. It was first administered for this purpose by Bricbeteau, in 1847, and has the sanction of Gross, Otis, Gouley, and many other distinguished names. While I have not witnessed the prophylactic effects of the drug in quite so striking a manner as has been observed by some others, I am not disposed to under-estimate its value, believing that it is far from being powerless in preventing the rigors which succeed urethral operations. To obtain the full benefit of the remedy it must be given half an hour before the use of instruments, and in doses of not less than ten or twelve grains. When the operation is one likely to be tedious and painful, ether should always be administered. I am not to be understood, however, as recommending quinine and anæsthetics in a simple procedure like that of gradual dilatation. Except in persons of a supersensitive organization, this operation can be conducted without creating much local or general disturbance.

As these urethral rigors frequently appear at the time of the first urination succeeding the use of the instrument, it is an excellent precaution to draw the urine with the catheter immediately after the operation, which will render its discharge by the natural passage unnecessary for some time. Two other agencies complete the means at our command to prevent the constitutional effects of urethral instrumentation,—namely, a suppository of opium, and hot fomentations applied to the perineum, the genitals, and the hypogastric region. Indeed, these last two remedies, with the use of the catheter, embody almost everything to be desired.

When, notwithstanding every precaution, an attack comes on, our attention must first be directed to moderate and shorten the chill, if prolonged, and, after this has passed over, to lessen and resolve the succeeding fever and to maintain an active state of the kidneys. To ameliorate the chill and to shorten its duration, little more can be done than to apply external warmth. When the reaction sets in, a febrifuge mixture, as the *mistura potassæ citratis*, containing a little morphia, with a few drops of tincture of aconite, will prove useful:

R Misturæ Potassæ Citratis, ℥vj;
 Morphine Sulphatis, gr. ss;
 Tincturæ Aconiti, gtt. xx.

M. Sig.—Tablespoonful every two or three hours.

When the signs of urinary suppression appear, the most energetic measures must be employed in order to supply other routes for the elimination of those materials which can only permanently be removed from the system by the renal organs, until the functions of the latter have been resumed. These vicarious routes are the skin and the intestines; and to use them to the best advantage recourse must be had to a saline cathartic, together with the free use of diaphoretics, assisted in their action by a hot bath or air-bath. I have used in some instances, with success, a poultice consisting of leaves of digitalis and flaxseed-meal, applied over the lumbar region. As other remedies had been employed without relief, I was disposed to attribute the action of the kidneys, in part at least, to this remedy. When pyæmia occurs, it must be treated on the principles already described under the head of complicated traumatic infective fever.

Urethral Fistula.

A fistula of the urethra is an abnormal track, one extremity of which communicates with the urethra and the other with the surface of the skin. The track is usually quite narrow, is at first surrounded by granulation-tissue, may be straight or sinuous, and in time becomes lined with an adventitious membrane. A fistula may occur at any portion of the urethra. Generally it is found communicating with the scrotal or the membranous division of the canal. Though the fistula usually has only a single opening at its urethral extremity, there may be several branches leading from the former and opening at different points on the cutaneous surface. The length and course of these fistulæ vary exceedingly, a circumstance which is largely determined by anatomical peculiarities of structure. When situated in the ante-scrotal part of the urethra they are short and straight; when in the scrotal portion they are rarely very long, and generally pursue an oblique course; while in the perineal division of the canal they are usually of considerable extent, follow a devious, winding course, and open on the surface at one or more points

FIG. 1254.



Urethral fistulæ opening on the perineum.

anterior to the anus and along the sides of the raphe, or forward between the scrotum and the thigh. (Fig. 1254.) The external orifices of these fistulæ are generally small, and when close to the raphe of the perineum and the scrotum are depressed and occupied by a crop of granulations, which sometimes rises into a little conical eminence. The discharge which flows from these channels may be slight or profuse, has a slightly yellow appearance, in consistence resembles

water or thin lymph, and is sometimes stained with blood. When attacked by acute inflammation, to which these fistulæ are very prone, the discharge becomes abundant and purulent in character.

In the early history of a fistula there will be found considerable inflammatory infiltration, tenderness, redness, and swelling, which reveal the mischief in progress, and finally culminate in the formation of abscess.

After the contents of the latter are evacuated, these symptoms subside, and

the parts apparently return to their natural condition, the opening contracting to a small point, which refuses to heal, and through which a portion of the urine (it may be only a few drops) escapes during urination, revealing the nature of the malady. In fistulæ of long standing, the frequent attacks of inflammation to which they are exposed render their sides dense and gristly from the plastic deposits which have occurred, and which in no small degree complicate their cure.

CAUSES.—The causes of urethral fistulæ are external and internal. Among the former are contusions, lacerations, shot and other wounds, and chancreous or cancerous ulcerations; among the latter, strictures of the canal, impaction of calculi, the rude use of instruments, and the prolonged wearing of catheters or bougies.

During the late American war a large number of urethral fistulæ followed shot lacerations, many of which were utterly intractable to treatment.

DIAGNOSIS.—The diagnosis of this disease is not a matter of any difficulty. The existence of an external opening, and the escape from it of urine, either in drops or in spurts, sometimes in a stream, during micturition, are signs sufficient to remove all uncertainty about the nature of the malady.

PROGNOSIS.—This may be considered from two points, namely, curability and danger to life. With regard to the first, much will depend on the situation of the fistula, and also on the extent of substance which may have been lost, fistulæ in the penile part of the tube being much more intractable to treatment than those in the perineal portion; though, even when situated in the latter, if there is a deep perineum, with much alteration of structure or with sinuses extending up between the prostate and the rectum and ramifying in different directions, the success of operative measures is attended with no small degree of uncertainty.

When, from extensive chancreous ulceration, sloughing, or shot or other wounds, there is a considerable loss of substance, though the resources of surgery are ample and ingenious to meet the defect, they are exceedingly liable to fail. Notwithstanding the condition of a patient suffering from urinary fistula is a most pitiable one, from the difficulty of preserving personal cleanliness, the immediate danger to life is not great. Yet, should it be allowed to remain without control, or prove defiant of treatment, the secondary effects of the disease are of such a nature, when the perineal part of the canal is involved, as eventually to undermine the health and to wear the patient out by inducing abscesses, cystitis, or disease of the kidneys.

Among other evils attending the disease may be that of impotence, from the semen not passing through the external meatus of the urethra, stalactitic formations deposited by the urine in the course of the fistulous track, and ulceration into the rectum (urethro-rectal fistula).

TREATMENT.—Obviously, the first thing in the consideration of a case of urethral fistula is to ascertain the cause of the disease. If it originates from stricture, which is a very common cause, the restoration of the canal to its original capacity must take precedence of all other measures. When this has been effected by the usual plans of treatment proper to stricture, the next object must be to prevent any water from entering the fistula during urination. For this purpose the patient must be instructed to perform self-catheterization, using the instrument as often as may be necessary during the twenty-four hours. It is always desirable to have fixed times for this operation. If done irregularly, the patient is liable to be taken by surprise and in his haste either injure the urethra or allow a portion of the urine to get into the fistula. If this treatment is carried into effect faithfully, many cases of fistula will close up spontaneously.

Should this event not follow, a careful inquiry must be instituted, to ascertain from what causes the failure proceeds.

Those most likely to exist are the following:

First. The absence of *live* granulating tissue along the fistulous canal, its walls being callous and gristly. The rough sensation communicated to the

fingers by passing a probe along the abnormal tube will disclose this condition. When it exists in a moderate degree, and the track is not too long, the defect may be remedied by carrying a crayon of nitrate of silver or sulphate of copper along the fistula once every three or four days, and in this manner revivifying the surface. For the same purpose, when the fistulous tube is long, injections of nitrate of silver or sulphate of copper—thirty or forty grains of the salt to the ounce of distilled water—may be used; or a silver probe dipped into nitric acid or acid nitrate of mercury can be employed.

In small fistulæ situated in the penile part of the urethra, particularly its ante-scrotal portion, Dieffenbach recommends what is termed a subcutaneous or *lace* suture. The edges of the fistula are first freshened by vesication and scarification, after which a needle bearing a silk thread, by being alternately introduced and again brought out, surrounds the abnormal orifice three-eighths of an inch distant from its border with a thread, drawing upon the ends of which makes the ligature subcutaneous and puckers together the sides of the fistula. The thread, after being secured, may be allowed to remain about four days, when it may be removed.

Should these means not prove successful, and the fistula is located in the spongy or penile part of the urethra, its edges should be pared, brought together, and retained over a soft catheter introduced into the bladder either by interrupted silver sutures or by twisted sutures. The catheter must be allowed to remain four or five days (if tolerated) without being removed, by which time the union should have taken place. In some cases of this kind I have employed the quilled suture, which supplies a very uniform pressure

FIG. 1255.



Fistula in the penile part of the urethra closed by quilled suture.

to the sides of the wound. (Fig. 1255.) If the tissues are at all scant, it will be necessary to dissect up lateral flaps before applying these sutures. Erections must be controlled by local applications of cold water, bromide of potassium internally, and anti-aphrodisiacal suppositories.

In the perineal portion of the urethra, callous fistulæ are not likely to yield to any remedy short of laying the parts freely open from the surface along the fistula into the urethra, packing the wound with lint in order to secure a continuous granulation from the bottom, and, after the chasm is pretty well filled up, beginning the periodical use of the catheter, as in cases of laceration of the urethra.

If there is more than one fistulous track, each in turn must be treated by incision.

Second. The closure of the fistula may be prevented by surrounding adhesions, or by the disturbing influence of muscular action; and in those opening on the perineum and involving the membranous portion of the urethra, this is likely to be the case. In this event a perineal section becomes necessary, and the fistula must be compelled to granulate from the bottom of the wound.

Third. The fistulous canal may become incrustated with calcareous matter from the urine, which will prevent the union of its sides. The pressure of this matter can be detected by a probe, or by the grating sensation communicated by the probe. The deposition can be dissolved by injections, along the sinus, of dilute hydrochloric acid, or by scraping its surface with a miniature curette or scoop.

In the case of an English engineer, who had been twice cut for stone in Wales, and who suffered from urethral fistula which had obstinately refused to heal, I discovered and extracted a long, spike-like stalactite from the track, after which the opening closed up.

Fourth. The membranous part of the urethra, when it is the seat of fistulæ, may become united, by inflammatory deposits, to the rectum; and, ulceration

setting up, the two canals may communicate, interchanging their contents, the urine finding its way into the bowel, and the flatus of the latter escaping into the urethra. This condition constitutes a *urethro-rectal fistula*. When the communicating opening is very small, a bilateral incision should be made across the perineum, in front of the bowel, and the two canals carefully dissected apart, after which the perineum must be divided from the surface along the false passage to the urethra. Both incisions will require to be loosely packed. If, however, the opening into the rectum is not large enough to receive the end of a small catheter, it will require to be laid open, as in ordinary *fistula in ano*.

Urethroplasty.

In cases of fistula attended with considerable loss of substance, resort may be had to urethroplasty. This operation, which consists in raising a flap of integument from parts adjoining the fistula and turning it into the abnormal opening, was long ago attempted by Sir Astley Cooper, and later by the French surgeon Delpech. Dieffenbach, Alliot, Ricord, Nélaton, and others have given considerable attention to similar operations, which, though well worthy of trial, do not, judging from my own experience, promise a very flattering success. Czerny has collected 82 cases of operations for the closure of urethral fistulae, with only 35 cures, leaving a failure of 58.9 per cent. In carrying into effect an operation of this kind, the edges of the fistula must, in the first place, be well denuded, so as to supply a raw surface of considerable extent adjoining the fistula. A flap must next be marked off of the same form as the opening to be filled, (but considerably larger), which, after being dissected up, leaving a sufficient base for the supply of blood (Fig. 1256), is turned into position, and its edges united with those of the fistula by a number of interrupted fine animal or silk sutures. Wire is too stiff to admit of nice adjustment. Nélaton performed an operation in which, after making two transverse cuts and vivifying the edges of the opening, the flaps were dissected up subcutaneously. (Fig. 1257.)

Alliot's operation, which carries the line of approximation away from the fistulous opening, consists in freshening a considerable surface on one side only of the fistula, and, after raising a square flap exclusively from the opposite side, drawing the latter across the opening and stitching it to the margin of the denuded side. In all of these procedures it is necessary to retain a

soft catheter in the bladder until the result of the operation is determined.

As the principal cause of failure in all these operations is the contact of the urine with the wound, which, in spite of the catheter, it is almost impossible to prevent, it has been suggested by Ricord, who himself adopted the plan in one case (a similar operation has been done by Ségalus and by Thompson), to open the membranous part of the urethra through the perineum and allow the urine to flow by this route until the union of the fistula has been effected. The magnitude of the evil is sufficiently great to justify a resort to this device, although its true value must as yet be considered as undetermined.

FIG. 1256.



Urethroplasty.

FIG. 1257.



Nélaton's operation for closing urethral fistula.

Persons who suffer from incurable fistulae of the urethra, opening on the surface of the perineum or scrotum, should lead an exceedingly temperate life, using a plain, substantial diet, and protecting the feet and body during cold and damp weather by warm clothing. Indifference on these points will be followed by alterations in the quality of the urine, which occasion inflammatory attacks in the course of the fistula, accompanied with severe local and constitutional disturbances. These, when they occur, are most properly managed by rest in the recumbent position, the use of refrigerant diluents, and hot fomentations or poultices applied directly to the parts. To prevent excoriation from the dribbling of the urine, the skin may be anointed with oxide of zinc ointment, and a broad T-bandage worn between the limbs.

Malformations of the Urethra.

Many of the malformations which have been enumerated by writers are exceedingly rare, and are to be regarded indeed as anatomical or physiological curiosities rather than as subjects of surgical interest.

These deformities may affect the position, form, and size of the meatus, or of other portions of the canal.

The *meatus* may be on one side of the glans; it has been seen above the pubes, and also in the groin. Instead of being a vertical slit, it may be round or irregular. It is sometimes unusually capacious, but more frequently preternaturally small. The latter condition is often an acquired defect in old men. Whether congenital or acquired, if it in any way impedes the easy discharge of the urine, the meatus should either be dilated by graduated bougies or incised, and afterwards prevented from contracting during healing by the daily use of a bougie.

Multiple meatuses have been observed, but, so far as I know, only one communicating with the urethra, the others either being slight depressions or terminating in a *cul-de-sac*.

Atresia of the meatus may be due to a soft adhesion of the sides of the opening, as is frequently seen in the labia of female children, or the occlusion may consist of a membrane more or less dense. The obstruction, though for the most part confined to the meatus, occasionally extends some distance into the glans. When the adhesion is soft it can be broken up by the end of a probe, but when of firmer consistence it will require incision and subsequent dilatation.

Entire absence of the urethra is associated with exstrophy of the bladder, or with its absence, the ureter terminating in the rectum. Partial absence of the urethra is sometimes seen in cases of hypospadias, and is limited wholly to the glans. It may become necessary to make an opening by a trocar, after which a soft bougie should be introduced and retained until the surface is healed. There are no examples recorded of a double urethra, except in the rare instances where two penile organs have existed.

Portions of the canal are occasionally found abnormally enlarged or contracted. Thus, the fossa navicularis may be greatly exaggerated in size, forming a considerable pouch; and the same condition is witnessed in the prostatic sinuses. Such abnormalities would favor the formation of urethral calculi. The opposite condition may be present, in which scarcely a trace of the scaphoid form of these two portions of the canal remains.

In the prostatic portion of the urethra the *veru montanum* may be unusually developed, causing a serious obstruction to the channel. In a few instances this part of the urethra has passed above or below the prostate body, instead of passing through it. Any obstruction of the urethra, whether congenital or acquired, eventually reacts on the other parts of the urinary apparatus by causing dilatation of the bladder, the ureters, and even the pelvis of the kidneys.

Hypospadias.—In the development of the penis during embryonic life the

position of the future urethra is indicated by a groove, the sides of which gradually close in until they finally coalesce, constituting a canal. The process advances from behind forward. When this lateral approximation becomes arrested, the defect is called *hypospadias*, from the Greek words *ὑπό*, "under," and *σπάζω*, to "open."

Hypospadias is therefore a congenital deficiency in the lower wall of the urethra, the latter terminating at the *frænum præputii*, or at any point between the *frænum* and the *scrotum*. A smooth gutter extends from the termination of the urethra forward to the extremity of the *glans penis*, indicating the upper wall of the canal, or it may terminate at the base of the *glans*, the latter being perfect and perhaps containing a rudimentary *meatus*. When the former is the case, the head of the organ presents a flattened appearance. When the urethra terminates near the root of the penis, it will be found in connection with a *bifid scrotum*.

In extreme cases of *hypospadias* the cleft, with a *testis* inclosed in its *scrotal sac* on each side, strongly resembles the external genitalia of the female. In one instance of this kind, where the remains of the penis were buried in the groove, the deception was so complete that the medical attendants informed the parents that the child was a girl, and, on the strength of this opinion, it was baptized as such. Nor was the error detected until a long time after, when the development of the penis revealed the true sex of the child.

Hypospadias is frequently associated with a preternaturally short *corpus spongiosum*, in consequence of which the organ is incurvated in a downward direction.

Hypospadias, when seated far back in the *scrotum*, renders its possessor fruitless, though not impotent. I treated successfully a gentleman, fifty years old, who had a large family of children, and in whom the urethra terminated one inch and a half back of the usual location. He was led to apply for relief on account of a troublesome vesical irritation, which he properly attributed to this cause. I have noticed a similar irritation to result from *hypospadias* on more than one occasion.

TREATMENT.—No operations in surgery are more unsatisfactory than those done for the cure of *hypospadias*, and yet there are many favorable cases, in which, by patience and perseverance, excellent results can be reached.

The most promising cases are those in which the urethra terminates near the *glans*, and where the spongy body is not short, giving rise to a downward curve.

It is always better, before attempting any operation, to allow the child to reach four or five years of age. As it is the urine coming in contact with the wound which renders our efforts abortive, I always leave the orifice of the abnormal urethra undisturbed, turning my attention wholly to the construction of the defective portion of the canal: if successful in this, the other can be conjoined with the latter by a second operation. By adopting this plan the urine is kept from defeating the union of the flaps, and the use of the catheter is avoided.

Persons suffering from very slight degrees of *hypospadias* sometimes are annoyed by an irritation at the orifice of the urethra, in consequence of a slight protrusion of the mucous membrane; they may also have vesical irritability. When no such inconvenience is experienced, and the person can be reconciled to his infirmity, it is not advisable to interfere.

There are two operations which I think are peculiarly well adapted to remedy the defect, and in neither of them is any tissue removed. The first consists in making two longitudinal incisions at the juncture of the skin and mucous membrane of the urethral gutter, one on each side, and then dissecting up flaps in an outward direction. These flaps, after being raised and their raw surfaces everted, are to be brought in contact with each other over a short lead or soft gum catheter of small size, and retained by either the quilled or the interrupted suture. When the deficiency is limited

to the glans penis, it will suffice to pare off a thin stratum of tissue on each side, and bring the edges together over a small catheter by means of deep silver sutures. The stitches should be removed on the fourth day, and also the catheter, or the latter may be taken away immediately on completing the operation, as its chief value consists in supplying a resisting medium over which to model the urethral arch. Should the attempt prove successful and the union of the flaps be consummated, in three or four months the second operation may be undertaken,—that of joining the old orifice of the urethra with the newly-constructed portion of the canal, and making the two continuous.

For this purpose, after introducing a catheter into the bladder, the incisions on each side of the crevice or chasm must be made transverse, taking care not to cut into the urethra, and, after dissecting the delicate flaps in opposite directions for a short distance, they are to be stitched together by fine silk sutures, previously well waxed.

The second method of closure is by one long and one short flap, the former being reversed so that the cutaneous surface is placed next to the urethra. A longitudinal incision is made on one side of the urethral defect, from three-eighths to five-eighths of an inch from its margin. The integument is next dissected a short distance in the direction of the urethra. A second incision, parallel with and running along the border of the canal, is made on the opposite side, and the flap raised for a short distance outward. The long integumental flap is now reverted, raw surface upward, carried across, and slipped under the flap of the opposite side, where it is to be secured by sutures. The short catheter is to be used, as in the other method, only for supporting the tissues by which the chasm is bridged. The stitches may be allowed to remain for four, or even five, days.

A portion of the long flap, that is to say, so much of it as is not covered by the short one, must granulate and cicatrize; and it will require several weeks before that end is accomplished. As in the first procedure, so in this, the junction of the urethral orifice with the newly-formed canal must be the work of a subsequent operation. Cold-water dressings constitute the proper applications during the after-treatment. Erections must be controlled by the use of cold, externally applied, with suppositories of opium, camphor, and lupulin.

Epispadias (from *ἐπί*, "over" or "above," and *σπάζω*, to "open") is an absence of the upper wall of the urethra, and is a much rarer defect than hypospadias.

As in hypospadias, so in epispadias the orifice of the urethra may be in the glans penis or at any point along the upper surface of the organ. When complete, and of course including the membranous and prostatic portions of the canal, the disease is usually associated with a congenital absence of the pubic symphysis and with exstrophy of the bladder. There is, I believe, only a single instance recorded, that of Dolbeau, in which this was not true. The position of the urethra above the cavernous bodies in epispadias is difficult to reconcile with the usual view of embryologists on the subject of the development of the male organs of generation. It probably assumes this position by a congenital separation of the cavernous bodies, allowing the spongy body to pass between and above.

Any operation for restoring the upper wall of the urethra will rarely be attended with success, and in complete cases, even if successful, does not confer on the bladder any power to retain its contents. Successful operations have been performed by Liston, Nélaton, and others.

The method adopted especially by Nélaton consisted in freshening the borders of the urethral groove, and then reverting over the canal a flap of integument, the cutaneous surface inward, which was covered with a second flap taken from the opposite side, the raw surfaces of the two being in contact with each other. When the integument of the penis was too scanty,

that of the scrotum was utilized by being raised, and, after making a small slit corresponding to its raphé, through which the penis was passed, it was placed over the raw surface of the other flap, the two forming a covering for the canal. Flaps may also be taken from the groins when there is not material enough to finish out the urethra, one being reflected and the other laid over its raw surface, and both stitched to the sides of the canal, previously freshened. The prepuce may likewise be pressed into service by the surgeon in closing the anterior part of the canal, by first paring away the edges of the latter, and then making a transverse opening into the prepuce, which can be slipped over the glans penis and connected with the denuded surfaces above. The groove in the glans penis is best treated by freshening the surfaces immediately external to the margins of the urethra, and then bringing them together by the interrupted or a twisted suture, using, in case the latter is employed, an exceedingly delicate pin. To accomplish a cure in epispadias several operations will be required, not attempting too much at a time. The catheter will be necessary during the treatment, though the wound is less exposed to the urine than that after the operation for hypospadias.

Foreign Bodies in the Urethra.

Foreign bodies enter the urethra in two directions, from within outward and from without inward. Very rarely do they originate in the canal.

From within outward.—The substances which descend into the urethra are generally renal or vesical concretions or calculi. These bodies are washed, during urination, into the urethra, where, in consequence of their size or irregularity of form, they become arrested and permanently fixed. If not soon dislodged, these calculi increase in size by a continued deposition of the salts of the urine, and almost occlude the urethra. In those parts of the canal which are normally large, as the fossa navicularis, and especially the prostatic portion, these bodies are more likely to be retained, as they are removed somewhat from the force of the stream during micturition, and become moulded to the figure of the channel in which they lie by the addition of new material from the urine. I have seen the prostatic sinuses so completely filled with a concretion that it must have prevented the discharge of either the seminal or the prostatic fluid, as the under surface of the foreign body, when removed, proved to be a perfect cast of all the inequalities of the floor of this part of the urethra.

SYMPTOMS.—The symptoms of the presence of a calculus in the urethra are generally very well defined. They commence suddenly, and generally during micturition, when the concretion is swept into the canal. They sometimes appear shortly after an attack of renal colic or follow a crushing operation for stone.

There is a sudden sense of smarting, tearing pain in the urethra, an increased desire to micturate, attended with straining efforts, and an obstruction to the stream of urine more or less complete, the latter being discharged in drops or in a number of small, twisted streams which fall at the patient's feet. These sensations may last for but a short time, as the body may be expelled during the next urination, when all inconvenience will disappear, leaving only a little soreness in the course of the canal. When the concretion is large or angular (in which last case it is likely to become entangled in the plications of the mucous membrane of the passage) it may remain for several days, the symptoms continuing urgent during the whole period of its detention, until at last, by an unusual impulse of the column of water, it is disengaged and expelled from the urethra. In other cases it will be found that all natural efforts prove unavailing for its expulsion, when it will become necessary to employ instrumental measures for its extraction. Such bodies, when allowed to remain, are liable to produce inflammation, abscess, and fistula of the urethra, retention of urine, and cystitis. A short time ago I

witnessed the death of a patient who perished from the evils incident to a large prostatic concretion which had not been detected until the man was in a moribund condition.

If any doubt exists in regard to the diagnosis, it may be solved by an exploration of the urethral canal, externally with the finger and internally by a catheter or sound. Such an examination will be particularly necessary in children, who are unable intelligently to express their sensations, and who are frequently the subjects of such attacks.

If the calculus is lodged in the ante-scrotal portion of the urethra, it may often be discovered by the finger pressed along the course of the canal externally. When in the membranous portion, a digital examination through the rectum may also disclose its presence. For internal examination a medium-sized catheter or sound, straight or slightly curved at the vesical extremity, is the proper instrument. In children I frequently employ a common pocket-case ductor having a smooth and well-rounded end. Whatever instrument is selected, it must be well oiled, and carried gently along the urethra until it touches the foreign body, which can be readily recognized by the rough, grating sensation communicated to the fingers.

Sometimes it may be necessary at certain points in the canal, where the sensations are liable to be misinterpreted, to move the instrument up and down several times, changing the direction of its extremity, and making counter-pressure externally with a finger, until any doubt which may have existed in regard to the diagnosis has been removed.

TREATMENT.—It is not necessary in every case of urinary concretion to subject the patient to operative interference. If the attack has come on within a few hours, a hot hip-bath and the free use of diluent drinks will often, by relaxing the muscular contraction of the walls of the urethra and increasing the flow of water, suffice for its extrusion. The patient may render the column of urine more potent for dislodging the obstruction by compressing tightly the meatus between the thumb and fingers and preventing for a short time the escape of water, a vigorous effort being made at the same time to discharge the urine. The distention of the canal in front of the foreign body, which is caused by this simple device, may be sufficient, when the resistance at the meatus is suddenly removed, to insure its being washed out. Not unfrequently, when the calculus is in the anterior part of the penile urethra and can be felt externally, the displacement can be assisted by pressing the body forward with the finger. In soft uric acid concretions I have succeeded in this way in crushing the mass into particles without using any force which would do violence to the walls of the canal.

When, notwithstanding the use of the above means, the body remains fixed, it will become necessary to resort to more active measures; and these must be determined by the position of the foreign body in the canal. When located in the prostatic urethra and that part of the membranous urethra which is behind the triangular ligament, the proper course is to push the offending body back into the bladder, which can readily be done by a large catheter with a well-rounded extremity. If, however, the obstruction is situated in the penile portion of the canal, the risks attending its restoration by force into the bladder are too great; it must be extracted; and in doing this the surgeon should adopt, first, the simplest resources for the purpose.

Among these the most convenient and efficient is to stretch the urethra in front of the stone to its full capacity by graduated bougies. Should this not succeed, resort must be had to some of the different ingenious instruments which have been devised for this purpose, in all instances first injecting the urethra with a quantity of sweet oil. If the concretion is in the fossa navicularis, behind the glans, it may be extracted by an ordinary pair of forceps; and when the resistance offered by the meatus to its removal is great, a slight incision may be made, provided dilatation proves inadequate for the purpose. When the body is not too large and the urethra is sufficiently capacious, I am in the habit of using the little scoop which is on one end

of the ordinary director. This can be passed down the canal beyond the concretion, when, by applying the concave surface of this instrument to the body, the latter may be dragged forward and removed. The process will often be facilitated by the counter-pressure of the finger on the outside. In like manner may be used the metallic loop of Marini, which is nothing more than a smooth, flexible wire, in shape resembling a fenestrated scoop, and having its convex extremity bent so as to form a slight curve.

The articulated scoop of Leroy d'Etiolles is an admirable appliance for getting in the rear of an obstruction and dragging it forward. (Fig. 1258.)

FIG. 1258.



Articulated scoop of Leroy d'Etiolles.

This instrument is introduced along the urethra straight, and, after passing the foreign body, its articulated end is turned down at any angle desired by means of a screw at its opposite extremity.

In the absence of these instruments, an excellent contrivance may be improvised by bending a piece of wire on itself like a hair-pin, spreading the loop a little at its convex extremity, and then turning it to a slight angle.

The value of all these instruments will depend on our ability to place them behind the obstructing body (Fig. 1259); and, while they are usually very efficient, it cannot, I think, be denied that, as in their use the urethra is not

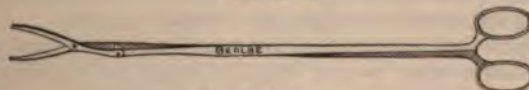
FIG. 1259.



Manner of extracting foreign substances from the urethra.

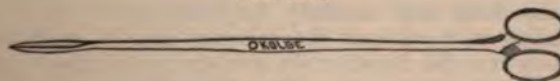
dilated in front, the canal is liable to suffer more or less injury by loose folds of the mucous membrane being pushed up in front of the body. A second class of instruments, having two blades, are designed to embrace the calculus on two sides, acting wholly as tractors, or on the principle of the common forceps. Such are the instruments of Matthews (Fig. 1260) and of Gross. (Fig. 1261.) The latter instruments necessarily, by their expanded blades

FIG. 1260.



Matthews's forceps.

FIG. 1261.



Gross's forceps.

stretching the urethra in front of the object grasped (Fig. 1262), are safer, though less effective, from the difficulty of seizing the foreign body, than those already described. A third variety of instruments are those constructed with three blades. The forceps which go sometimes by the name of Hunter, and at other times by that of Voilemier or of Civiale (Fig. 1263), are of this kind.

The instrument is introduced with the three blades closed, and when the concretion or other substance is reached they are expanded over the periphery

FIG. 1262.



Foreign body grasped by forceps.

of the body, which, by the retraction of the blades, is afterwards firmly embraced in their grasp.

Occasionally it happens that a stricture in the course of the urethra has

FIG. 1263.



Hunter's or Civiale's forceps.

prevented a mass of gravel from passing, until finally it has become firmly impacted. No efforts can be made for its extraction unless the stricture has been fully dilated. When the calculus is so large and so firmly impacted in the urethra as to defy extraction by any of the means described, there remain only two plans for its removal,—by *crushing* and by *incision*.

Crushing a calculus.—For carrying out the first plan, which is a very ancient operation, there are two instruments, the miniature lithotrite of Civiale, or an instrument resembling Exeter's ball-extractor, and the drilling lithotrite of Paulus Ægineta or of Reliquet. (Fig. 1264.)

FIG. 1264.



Reliquet's lithotrite.

The applications of these instruments are so limited, the difficulty and uncertainty attending their adjustment to the foreign body so great, and, above all, the danger to the canal so imminent, that they might well be eliminated from the surgery of the urethra.

Incision is a safer and more expeditious method of managing cases of stone which cannot be extracted through the normal channel.

When the concretion is lodged in the membranous or prostatic part of the canal, the procedure may be not inaptly compared to that of cutting for stone. The rectum should be emptied, and the patient etherized and placed in the lithotomy position. A staff is next passed down the urethra to the obstruction, when an incision should be made in the raphé, between the scrotum and the anus, and carefully deepened until the body is reached. The urethra being now opened, the calculus can be extracted by passing behind it a scoop or a flat hook, or by introducing a finger into the rectum and thrusting it out by pressure from behind forward. The subsequent treatment of the wound will be the same in all respects as after lithotomy.

When the concretion is situated in the penile portion of the urethra, it should be exposed and removed by a direct incision, the wound immediately closed by the twisted suture, and the urine drawn by the catheter for seven or eight days, or until the parts have healed.

If the scrotal part is opened, it may be found necessary, in order to avoid

urinary infiltration, to separate the two halves of the scrotum and retain them apart for thirty-six hours, by which time the union of the parts will have sufficiently progressed to prevent extravasation.

The bodies which are lodged in the urethra from without are either introduced designedly from a wanton or perverted disposition to trifle with the sexual organs, or from accident. In a few instances they have been inserted, either from mischief or from downright wickedness, while the patient has been deeply intoxicated. Among the materials generally comprised under the first head are straws, slate-pencils, hair-pins, pebbles, cherry-stones, leather strings, needles, pins, etc. Those which lodge in the urethra from accident are, for the most part, portions of soft bougies or catheters. A body once in the urethra has, it is believed by many, a strong tendency to travel in the direction of the bladder, notwithstanding that the mouths of the lacunæ, which open forward, and the direction of the stream of water in urination, would render such a tendency improbable. For a long time I was skeptical in regard to this retrograde movement, except in the case of bodies having a particular form or with bristling points, in which case the explanation is plain. I have had ocular demonstration, however, of this urethral and vesical deglutition of substances in which neither of these conditions existed.

While once operating on the perineum of a private patient, the soft catheter (rather a short one), which was in the urethra, suddenly slipped from the fingers of an inexperienced assistant, and immediately disappeared through the meatus. A cry of surprise from the discomfited nurse called my attention to what had occurred. I instantly grasped and firmly compressed the penis in my two hands, and by pushing the corpus spongiosum forward with one hand, while with the other the organ was pressed backward, I got the catheter sufficiently near the meatus to enable me to seize it with a pair of forceps. On another occasion, finding the resistance to the extraction of a catheter very marked, I proceeded, in order to satisfy myself of the reality of the so-called suction power of the bladder and urethra, to dally with the instrument for a short time. Accordingly, after pulling it a little way through the orifice of the urethra, I would relax my hold, when it would be immediately drawn in, and sometimes with singular rapidity. This behavior of the urethra under the stimulus of foreign bodies introduced from without is the more remarkable as it does not appear to be so influenced by bodies which enter it from the opposite direction. As it must operate through a reversed action of the muscular fibres which surround the canal, the only theory which occurs to me as competent to explain the reversed action in the one case and its absence in the other is a probable difference in the effect produced in the order of muscular action, according as the irritation primarily affects the terminal nervous loops or the nerves nearer their origin.

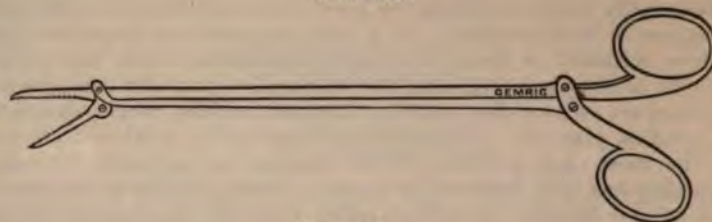
TREATMENT.—The bodies which are introduced into the urethra from without are so diverse in kind, shape, and consistence that there is opened a wide field for the exercise of surgical ingenuity. Round bodies, such as beads, cherry-stones, and shot, will be most readily extracted by some of the different forms of scoops already described. Cylindrical or flat substances, as lead-pencils, bits of catheters, and pieces of wood or straw, can be frequently removed by the urethral forceps, or by the forceps of Luar. (Fig. 1265.)

Hair-pins, which are almost always introduced with the closed extremity downward, are best managed by pressing their points together, grasping the urethra between the thumb and fingers, and either seizing the pin with the forceps, or, as was done on one occasion by Mr. Avery, slipping over the points a piece of gum catheter. The elasticity of the branches of the pin when released from the pressure of the fingers is sufficiently strong to make it cling to the tube until it is extracted.

Hydrostatic pressure may be profitably employed for the expulsion of bodies which possess regularity of form. For this purpose a small flattened canula with a smooth extremity should be passed a short distance behind the obstruction. Into the exposed end of the canula is next fitted the nozzle of

a syringe, and while the water is forced into the urethra the latter is strongly compressed about one inch and a half distant from and both behind and in

Fig. 1265.



Urethral forceps.

front of the foreign body. Should the latter not be floated forward, it may be moved by sliding the posterior finger forward along the urethra. By repeating this process of extreme distention the body may, little by little, finally be extruded.

Beads may be removed by bending the end of a probe into a hook and passing it beyond the body, when, on withdrawing the instrument, the point is likely to pass through the opening of the bead and both come out together. A pin or needle, when sufficiently long to be located and felt, may be thrust through the walls of the canal by grasping the urethra at a point answering to the head or the blunt end of the body, and then bending the penis backward to an acute angle, as was done by Boinet in the case of a hair-pin. It may then be drawn through, or, if the head will not admit of this, the sharp end may be cut off, and the remaining portion held until it can be secured by the urethral forceps and withdrawn through the natural channel.

Dr. Keyes, of New York, has suggested, in such cases, the feasibility of extraction by a Thompson's divulsor, the branches of which being opened and again screwed together might possibly catch the offending body. Another plan, which it has occurred to me might be practicable if the pointed body lay free in the urethra, is the introduction of a metal tube like a catheter, its end large and open, and filled for a short distance (immediately before being introduced) with plaster softened with water; then, while fixing the pin with the fingers on the outside of the urethra, the instrument should be carried along the canal down to the foreign body. Should we be fortunate enough to include its extremity in the soft plaster, the latter, as soon as it became hard (the work of only a few minutes), would hold the pin with sufficient firmness to allow of its being removed.

Tumors of the Urethra.

The male urethra is rarely affected by morbid growths. Those which occasionally exist are of three kinds, namely, polypoid, vascular, and papillary.

POLYPOID GROWTHS are olive-shaped or oblong, with pedunculated attachments. The surface may be smooth and pale, or red and granular. Though no part of the canal can be said to be exempt from such tumors, the fossa navicularis and the prostatic portion are generally the favorite locations for their development. They may be single or multiple, consist of fine interlacing threads of connective tissue and blood-vessels, and, beginning in the submucous tissue of the urethra, are covered with an attenuated layer of its mucous membrane. They seldom give rise to any pain, and may exist for some time without being suspected. They at length provoke frequent micturition and vesical tenesmus, offering considerable impediment to the flow of the water, so that the patient is unable to project his stream any distance beyond the meatus, or it may be divided into several small streams. When the tumor is in the navicular fossa, it may be exposed to the eye by expanding the sides of the urethra behind the meatus with the blades of the dress-

ing forceps. When seated deeper in the canal, an exploration with a soft bulbous bougie may reveal its existence, by the hitch which is felt when the body is passed in withdrawing the instrument.

TREATMENT.—Urethral polypus is most effectively removed by being grasped between the blades of a urethral forceps as close as possible to its base, and, by repeated turns of the instrument, twisted off from its attachment. This is not a difficult task when the growth is in the navicular fossa; but when located farther back it is the work of patience and much delicate tact. The silver canula and wire noose used by Cloquet in extracting foreign bodies from the urethra may be advantageously employed for this purpose. The removal of these tumors is attended with no serious hemorrhage, and, if the bleeding should be protracted, cold and pressure around the organ, either with or without the use of the catheter in the canal, will be preferable to the use of cauterizing and astringent remedies internally.

VASCULAR GROWTHS.—These tumors, quite common in the female urethra, may in rare instances be found in the male urethra, and, so far as my own observation goes, are located immediately within the meatus. The growth is red, spongy, somewhat flattened, and less sensitive than similar formations in the female. Its base may be broad or narrow, and in micturition it may protrude slightly through the external meatus. These growths do not differ in histological formation from those seen in women, being made up of a complex net-work of blood-vessels, connective tissue, and nerves, covered with urethral epithelium. They will be more particularly considered under the head of diseases of the genito-urinary organs of the female.

The treatment consists in excision, with cauterization of the raw surface left by nitric acid, which should be followed by the injection of sweet oil into the canal.

VILLOUS OR PAPILLOMATOUS GROWTHS are next in frequency to the polypoid; they are not necessarily confined to any particular division of the urethra, and may be scattered along its entire length; the tumors, varying in size from a hemp-seed to a marble in the male, are made up of filamentous prolongations consisting of blood-vessels and connective tissue and presenting an arborescent or a cauliflower appearance.

These growths are capable of inducing the most severe vesical tenesmus, often attended with loss of blood.

Evulsion or strangulation and subsequent cauterization constitute the proper treatment.

Urethritis.

Urethritis occurs both as a non-specific and a specific inflammation of the mucous membrane of the urethra; these, though having many points of resemblance, are nevertheless entirely distinct affections.

NON-SPECIFIC URETHRITIS is characterized by heat, fullness, and tenderness along the course of the urethra, with some muco-purulent discharge, and a smarting or scalding sensation during micturition.

CAUSES.—The inflammation is frequently the result of sexual intercourse, and produced by the irritating effect of leucorrhœal and menstrual discharges on the mucous membrane of the urethra. It is often occasioned by excessive venereal indulgence, by exposure to cold, especially in persons of a lymphatic temperament, by the presence of urethral stricture, of foreign bodies in the canal, of stone in the bladder, or of hemorrhoids, by the use of hot aromatic substances, and occasionally by the administration of certain drugs, as turpentine, balsam of copaiba, guaiac, and iodide of potassium.

Alterations in the constitution of the urine will also serve to give rise to a simple urethritis, as in cases of oxaluria, or in the lithic acid diathesis, the inflammation being the result of mechanical irritation produced by the crystals of oxalate of lime or uric acid on the mucous membrane of the urethra.

The diagnosis of non-specific urethritis will be considered under the head of gonorrhœa.

TREATMENT.—In the treatment of non-specific urethritis it is of the first importance to ascertain the cause of the malady, and, if possible, to effect its removal. If it results from contact with irritating vaginal or uterine secretions, sexual abstinence and cleanliness is all that is necessary. If stricture of the urethra exists, it must be removed by treatment appropriate to cases of this nature. If it arises from the employment of certain medicinal agents, or from disturbances of the digestive organs, leading to mal-assimilation of the food and to changes in the character of the urine, in the one case the use of the suspected drugs must be suspended, and in the other the evil must be corrected by a properly regulated diet, avoiding fats and sugars, by exercise, and by the adoption of such remedies as are calculated to correct the state of the urine. Among these may be enumerated infusion of gentian or quassia, nitromuriatic acid, phosphoric acid, bicarbonate of potassium, and, possibly, chalybeates.

Very little local treatment is demanded. The discharge usually disappears spontaneously in the course of eight or ten days. Should it linger, it may be removed by mild astringent injections of green tea, rose-water, or acetate of lead (half a grain of the acetate to one ounce of water).

Specific Urethritis, or Gonorrhœa, is the most common of all venereal diseases. The term gonorrhœa (derived from the Greek *γονή* and *ῥέω*, meaning a flow of semen), like many others in our medical nomenclature, has been badly chosen. But as common usage, independent of etymological incongruity, has affixed to the word a definite meaning, there does not appear to be any urgent necessity for changing the term. The Saxon word *clap* is the vulgar synonyme for the disease.

Gonorrhœa is an inflammation of the mucous membrane of the urethra, accompanied by a contagious muco-purulent discharge. Though at one time supposed to be a syphilitic disease and dependent on urethral ulceration, it has been established beyond controversy through the observations and experiments of careful observers, especially those of Ricord, that, except in the manner in which gonorrhœa is contracted, the two diseases have no relationship. Gonorrhœa is purely a local affection, and wholly powerless to produce any constitutional taint.

CAUSES.—While I do not deny the possibility of a specific urethritis originating from the contact of the mucous surface of the genitalia with infected clothing, such instances must be very exceptional. The disease is almost always caused by sexual intercourse, one of the parties to the act suffering at the time from gonorrhœal inflammation. There is no evidence that the disease ever arises from contact with the ordinary vaginal or uterine discharges, as leucorrhœa or the menstrual fluid, or that it can be induced by sexual excesses. There are but two conditions requisite for its development,—namely, the presence of a specific virus or poison, and the application of that poison to some portion of the mucous membrane of the genital organs.

This virus is capable of producing a specific form of inflammation not only when brought into contact with the mucous tissue of the penis and prepuce of the male and the vagina and urethra of the female, but also when applied to other mucous membranes, as those of the eye, the uterus, the bladder, and the rectum. Whether the lining membrane of the mouth and nasal passages is equally vulnerable to the action of the poison has not yet been satisfactorily determined. Of the susceptibility of the rectal mucous surface there can be little doubt. Allingham and other writers have recorded several cases of rectal clap in the persons of prostitutes.

The conditions which predispose to gonorrhœa are a large meatus, hypospadias, a redundant prepuce, which serves to retain the vaginal discharges, and prolonged or frequently repeated intercourse.

Nature of the virus.—Until recently the most careful examinations, chemical and microscopical, failed to discover in the products of gonorrhœal inflammation anything different from ordinary pus. There are reasons for

believing that the peculiar *materies* which confers the specific property on gonorrhœal matter is the product of cocci and intimately related to the pus-corpuscle, as the experiments of Rollet show that the liquor puris and the mucous constituent of the discharge, when separated by filtration, possess no infecting quality. A number of these organisms have been observed in the mucus and pus of the urethra, as the diplococcus subflavus, micrococcus citreus, micrococcus conglomeratus, etc., but the gonococcus or the micrococcus of Neisser appears to be the specific offender.

After exposure, a period elapses between the application of the gonorrhœal matter and the development of the disease, which is the stage of *incubation* or *latency*, a period subject to considerable variation, sometimes not exceeding twenty-four hours, at other times lasting for eight or nine days. In a few instances well-defined symptoms have been observed six hours after intercourse. Fifteen or sixteen days may be regarded as the utmost limit of dormancy. The usual period for the development of the disease is between the fourth and the seventh day.

SYMPTOMS.—The earliest objective evidence of inoculation is a certain feeling of uneasiness at the urinary meatus, which gradually assumes definiteness in an itching, worrying irritation. On examination the labia of the meatus will be found slightly tumid and red, and perhaps glued up with a viscid secretion. As this gluing discharge increases, the uneasiness at first felt in the region of the meatus extends farther back along the urethra, giving rise to a sense of fullness and weight in the penis, and is accompanied with severe pain, heat, and scalding on passing water, in addition to which the orifice of the urethra feels raw, burning, smarting, and sore.

The discharge which is first observed is the product of the mucous follicles of the urethra, their secretion being increased by the local irritation.

In the course of four or five days from its first appearance the discharge becomes copious and purulent, being at first slightly yellow, and finally greenish, and not unfrequently, when inflammation runs high, stained with blood, from the rupture of the overstrained vessels of the mucous membrane.

As the inflammation approaches the zenith of its intensity the entire organ becomes tender and swollen, and the stream of urine is diminished in size, in consequence of the submucous infiltration narrowing the lumen of the canal. The glans penis is particularly red, and the prepuce œdematous, and the patient is harassed with troublesome erections and a frequent desire to micturate.

Sometimes there is complete retention of urine. This may arise from great irritability and spasmodic contraction of the muscles of the membranous and prostatic portions of the urethra, or from inflammatory swelling of the prostate body.

When the deeper parts of the canal are involved, there are fullness and soreness in the perineum, and not unfrequently in the groins, attended with swelling in the inguinal glands. When the inflammatory symptoms are more than ordinarily severe, the constitution sympathizes in the local disturbance, giving rise to increased heat of the general surface, thirst, fever, and nervous restlessness.

After the lapse of from ten to twenty days, the disease reaches its culminating point, when the symptoms begin to abate. The discharge lessens in quantity, becomes thinner and paler, and at length amounts to only a few drops, which collect in the meatus or glue together its sides, or which are rendered visible only by pressing with the fingers the deeper portions of the urethra, where the inflammation lingers longest.

With the subsidence of the discharge, the urgent desire to urinate and the smarting attending the act, together with erections and chordee, disappear. The time generally required for the declination of the inflammation is seldom less than eight or ten days. There are, therefore, three quite natural stages in the curriculum of gonorrhœal disease,—a stage of *incubation*, one of *development* and *maturation*, answering to the acute inflammatory stage of

writers, and one of *declination*, the three stages ordinarily requiring for their completion from five to six weeks.

The inflammation, which, in the male, commences at the meatus urinarius and slowly creeps backward, seldom, if not interrupted by treatment, reaches the whole length of the spongy part of the urethra earlier than about the sixteenth day from its development, and manifests a tendency to linger in the deep portion of the penile urethra and in the navicular fossa even after all traces of the disease have disappeared from the intermediate portions of the canal. Inflammation, however, is not limited to the spongy urethra. It may travel to the bladder or over the glans penis (balanitis), or to the under surface of the prepuce (posthitis).

PATHOLOGY.—The pathological changes which characterize the progress of the disease are similar to those witnessed in acute catarrh of the mucous membranes. The vessels of the mucous membrane lining the canal, the follicles and lacunæ, are found deeply congested, giving a red, shining appearance to the membrane. The submucous tissue is filled with cell and lymph infiltration, giving rise to considerable thickening, which at points where the inflammation has been very severe is liable to remain and lay the foundation for stricture. When the disease has not been actively treated, and passes into the chronic state or into a gleet, the papillæ of the mucous membrane may become hypertrophied, giving rise to granulations which rise above the common level of the membrane and furnish a discharge of a light color and of the consistence of thin syrup.

DIAGNOSIS.—As there is a urethritis of a non-specific character, from which the purest individual may suffer, it is exceedingly important to be able to distinguish it from the specific form of the disease. Is such a differential diagnosis possible? I believe it is; and I feel confident that several times in the course of my professional life I have been able to restore the peace and confidence of families, where distrust in the fidelity of the conjugal relation had no just foundation, but nevertheless threatened the most serious consequences.

In simple or non-specific urethritis the inflammation is far less acute, the discharge much less copious, and the scalding less severe than in gonorrhœa. There is no chordee, and, above all, the disease is never inaugurated by that peculiar *itching* pain at the orifice of the urethra which belongs to gonorrhœa; it disappears spontaneously without treatment, seldom continuing beyond eight or nine days, and leaving no chronic discharge in its wake. I am aware that profuse muco-purulent discharges are said often to accompany simple urethritis; but I have never seen such.

TREATMENT.—Gonorrhœa, though generally a very manageable disease, is the subject of so much empirical tampering that there are few affections which entail more moral and physical suffering. The disease furnishes a rich harvest for unscrupulous quacks, and men are drawn into the snare like foolish birds. Physicians themselves are sometimes betrayed into a routine method of combating the disease without reference to its stage.

There are two plans of treatment. The one aims at cutting the disease short, arresting it suddenly, and is designated the *abortive* method. The other proposes to accomplish the cure in a more gradual manner, by the rational use of means adapted to the severity of the stage of inflammation.

The abortive treatment is attempted in different ways. In one, a single strong injection (forty grains of nitrate of silver to one ounce of water) is thrown into the urethra. Others prefer a daily injection of a less powerful solution (ten grains to the ounce of water), and still another class of practitioners use a weak solution (one-quarter of a grain to the ounce of water), but repeat the injection every three or four hours. The employment of a stronger solution for the purpose of putting a sudden termination to specific urethritis merits, in my judgment, the most unqualified condemnation. If it were always employed before the inflammation had become fairly developed, the evil would be less; but application for relief is rarely made at this

stage, and hence the common sequels of adding fuel to the flame are epididymitis, prostatitis, cystitis, stricture, and even peri-urethral abscesses.

Two things should be kept clearly before the mind of the practitioner in treating a case of gonorrhœa: first, that the inflammation, if left to itself, is prone to pass from the acute to the chronic state; secondly, that there is no specific for the disease. One of the great difficulties which is encountered in managing a case of gonorrhœa is the inability, in most instances, to place the patient under those hygienic restrictions which are important factors in the treatment of any inflammation. These include rest, proper food, drink, pure thoughts, and the absence of all mental and physical excitement.

The disability is not sufficiently great to compel the patient to relinquish his daily occupations. In hospitals, where the authority of the physician is supreme, and where most of the conditions specified can be enforced, the time required for the cure of gonorrhœa is much shorter than in private practice, and the complications are less common.

In the first stage of the disease, when the irritation is confined to the urethral orifice, and the mucous discharge is just making its appearance, the patient should be advised to relinquish business and go to bed for a few days. There will be much time saved in treatment if such obedience can be exacted. Whether this advice is followed or not, the diet should be carefully regulated, all stimulating articles of food and drink being discarded, and should consist chiefly of milk, bread, butter, tea, and fruits, unless the patient is pale, anæmic, and broken in health, when the nourishment must be more liberal. The bowels should be kept in a soluble condition by a saline aperient, for which purpose a tablespoonful of a solution of bitartrate of potash (3i of the salt to 3vj of water) may be used three or four times a day; and, in order to render the urine as unirritating as possible, the effervescent mixture may be directed, or an alkaline diluent, consisting of an infusion of slippery elm or flaxseed, to which is added some bicarbonate of potash or soda and a small amount of lemon-juice to render the liquid more palatable. In addition to these measures, the penis should be lightly and frequently dressed in wrappings of old linen, wet with hot water and laudanum; and, to protect the glans and prepuce from the irritation of the discharge, circular pieces of soft linen, large enough to cover the head of the penis, and with an opening cut in the centre, opposite the meatus, should be spread with a little oxide of zinc ointment, placed over the glans, and kept there by drawing the foreskin forward. This simple contrivance will often prevent the occurrence of a balanitis or a posthitis. When the patient is a walking one, some attention must be given to the protection of his person and clothing from the urethral discharges. For this purpose many advise the use of rubber sheaths or condoms; these, however, give rise to too much heat: when used, they ought not to be worn in contact with the skin, but with a soft rag interposed. A piece of old linen tied over the organ, and which can be replaced as it becomes soiled, is a preferable dressing.

Injections are to be employed two or three times a day, and should be of the mildest character, simple warm water or rose-water being the most suitable.

Whether the patient is in bed or walking about, it is advisable to keep the penis elevated, so as to empty the vessels of the organ as much as possible.

In from four to six days, under this treatment, the severity of the inflammation will have been greatly lessened, which may be known by the diminished turgescence, scalding, pain, and discharge, indicating the culmination of the second and the beginning of the third stage, or that of declination. Then we may venture on the use of astringent injections and certain internal remedies which exercise a controlling influence over the disease.

If, however, the inflammatory symptoms do not abate, such agents must be withheld, as their use will only aggravate the already too great vascular action. In such cases leeches may be advantageously applied to the perineum,

and fomentations of water as hot as can be borne should be kept constantly in contact with the scrotum, penis, and perineum. Half an ounce of neutral mixture, each dose containing one-sixteenth of a grain of morphia and four drops of the tincture of aconite, should be given every three hours until the urgent symptoms have been subdued, when, after an interval of two or three days, the urethral medication may commence.

A great variety of articles are employed as injections, the most popular being acetate of lead, sulphate of zinc, acetate of zinc, sulphate of copper, nitrate of silver, tannic acid, and alum.

No one of these injections will answer in every case. They require to be changed; but, in my own experience, the sulphate of zinc has proved, in a majority of cases, the most satisfactory.

It is necessary to begin always with a weak injection, increasing the strength according to the tolerance of the urethra. When the smarting following its use is severe, or even not severe, but prolonged, the proper limit of strength has been exceeded. Half a grain of the sulphate of zinc to one ounce of water is quite strong enough at first, and, if well borne, it may be increased gradually to five or six grains; and the same rule may be observed for the acetate of lead. If the nitrate of silver is employed, one-fourth of a grain to the ounce of distilled water may be regarded as the minimum and two grains as the maximum strength of the injection. These remedies should be used three times a day, always directing the patient to urinate before they are thrown into the urethra, in order that the canal may be washed out, and that the fluid may act directly upon the inflamed surface of the mucous membrane.

Besides the injections which have been enumerated, there are many other formulæ, each of which has its particular advocate. Among these may be mentioned that of Mr. Lloyd,—chloride of zinc, gr. i-ij; water, ℥iv; that of Caby,—subnitrate of bismuth, gr. xv; glycerin and mucilage of acacia, of each ℥ijss; dried alum, gr. ij; water, ℥i; and last,—tannic acid, gr. iv; water, ℥i.

Some instructions as to the mode of making urethral injections will not be out of place here.

The glass syringe, though much in use, is not a desirable instrument, being liable to break and wound the urethra. The piston rarely works properly, allowing the fluid to pass back along its sides. Hard rubber is a much safer and better material, and always to be preferred for this object. The syringe should have a capacity of two or three drachms, and its nozzle should be perfectly smooth, well rounded, and not exceeding three-eighths of an inch in length. (Fig. 1266.)

After filling the syringe with the liquid, turning the point upward and

FIG. 1266.



Hard rubber syringe.

expelling the air, introduce the nozzle along the lower wall of the urethral orifice, holding the instrument between the thumb and middle finger of one hand, with the index finger resting against the piston, and, while the lips of the meatus are pressed lightly together with the finger of the other hand, force the contents of the syringe into the canal.

The nozzle is now to be withdrawn, while the meatus is kept closed with the fingers, and the injection retained for three or four minutes, during which time the under surface of the urethra should be gently rubbed backward and forward with the fingers of the unoccupied hand, so as to distribute the fluid along the spongy part of the canal and to insure its contact with the entire surface of the corresponding portion of the mucous membrane.

Large injections are not necessary; indeed, they are liable to do harm by entering the bladder. The capacity of the spongy urethra does not exceed two drachms, and when more than this amount of fluid is employed, as is sometimes done, with a view to unfold the plications of the mucous membrane, so that no part shall escape medication, firm pressure should at the same time be applied with a finger to the canal behind the scrotum. Mr. Durham uses a syringe with a nozzle, which throws the stream forward as the piston is sent home.

It is during this stage that the patient is frequently harassed with painful erections. The free use of alkaline drinks, with hot fomentations, the frequent immersion of the penis in hot water, an occasional dose of Dover's powder or of bromide of potassium, and light bed-covering, at the same time not allowing the urine to accumulate in the bladder, constitute the best means of preventing this complication.

During the stage of declination, the diet of the patient may be improved. If he is in the habit of taking wine, a little claret may be allowed, and permission may be given to sit up a part of the day. Under this treatment the disease gradually improves, so that in the course of three or four weeks all traces of inflammation will have disappeared. Notwithstanding that the recovery may appear complete, the patient must be instructed on several points, otherwise he will have the mortification of seeing the discharge return. Exercise must be moderate. All long walks, heavy lifting, severe straining efforts, and sexual indulgence are to be avoided. All impure reading or lascivious thoughts, at any time degrading, are now particularly injurious; and all kinds of stimulants, except a little red wine, as well as highly-seasoned articles of food, are to be avoided.

A weak injection of sulphate of zinc or acetate of lead, used once a day, and continued for one or two weeks after all external manifestations of the disease have disappeared, is also a precautionary measure of great value.

Although in a large majority of cases local remedies are quite sufficient for the treatment of gonorrhœa, the cure is undoubtedly facilitated by the internal administration of certain articles of the materia medica, among which balsam of copaiba has long held a prominent rank and one which neither time nor experience has in the least diminished.

This remedy is considered by many to be suited to every stage of the disease, an opinion in which I do not concur. It is only when the acute symptoms have begun to subside, or at a period consistent with the use of astringent injections, that I regard its employment as proper. Copaiba may be administered in different formulæ. The most convenient, and, in private practice, the least objectionable, is in the form of capsules, each containing about ten minims of the copaiba. Two of these taken four or five times a day are usually well borne without disturbing the stomach. Or it may be administered in mixture, associated with an alkali and an anodyne. The following formula is one which I find answers a very good purpose:

R Balsam. Copaibæ, ʒv;
Muc. Acaciæ, ʒij;
Liquoris Potassæ, ʒijss;
Syrupi Hyoscyami, ʒiss;
Aquæ Menthe Pip., ʒijss;
Tincturæ Opii Camph., ʒss;
Ol. Gaultheriæ, gtt. xv.—M.

Sig.—Tablespoonful three times a day.

FIG. 1267.



Injecting the urethra.

Though the action of copaiba is a local one, affecting favorably the inflamed mucous surface as it is passed in the urine, this salutary property is acquired while passing through the kidneys, as it has been conclusively demonstrated to be powerless to cure when injected directly into the urethra. This statement is corroborated by the history of a patient of Ricord's who suffered from gonorrhœa and who at the same time had a urethral fistula. Copaiba was given, and the man was directed to allow his water to pass through the abnormal opening. The disease disappeared in that part of the urethra which was behind the fistula, but continued in the remaining part of the canal. He was now ordered, by closing the accidental opening with his finger, to pass the urine entirely by the natural channel; after which the anterior part of the urethra was also cured.

Copaiba is liable, when given too freely, either to disturb the stomach or to develop a cutaneous rash which is attended with considerable heat and itching. The latter is a matter of no consequence; it neither detracts from the value of the remedy nor contra-indicates a continuance of its use, as the irritation of the skin is a temporary inconvenience, which disappears under the use of hot baths and a lotion of a weak solution of carbolic acid.

The gastric symptoms are of more importance, and suggest either lessening the dose or the entire suspension of the remedy.

Other articles, as cubebs and the oil of sandal-wood, possess unquestionable value in the treatment of gonorrhœa. Though much inferior to copaiba, they may be used with great advantage in cases where the latter develops gastric uneasiness. They can be given most conveniently inclosed in capsules of gelatin.

A variety of gonorrhœa known as *Gonorrhœa sicca* is described. I have never witnessed anything answering to this disease. It is represented as presenting the ordinary signs of urethral inflammation, viz., fullness, heat, and swelling of the organ, with scalding micturition, but unaccompanied by any discharge.

Complications.—The complications which are liable to supervene in the progress of a case of gonorrhœa are chordee, follicular inflammation, balanitis, posthitis, prostatitis, inflammation of Cowper's glands, prostatic cystitis, retention of urine, hemorrhage, peri-urethral abscess, chancre, herpes preputialis, bubo, embolism of the dorsal vein, and epididymitis.

Chordee is an exceedingly common accompaniment of gonorrhœa, occurring most frequently during the night: it is provoked either by lascivious dreams, by distention of the bladder, or by the warmth of the bed. It is during the severity of the inflammatory stage that these attacks are most distressing, often continuing for a long time without intermission. The cells of the spongy tissue become painfully turgid, the penis being curved either downward or in a lateral direction, according as the inflammatory infiltration occurs in the corpus spongiosum or in one of the corpora cavernosa, rendering the affected parts inextensible.

TREATMENT.—To prevent chordee, the patient should be allowed the free use of alkaline diluents, with hot fomentations, or the frequent immersion of the penis in hot water, with an occasional dose of Dover's powder. The bed should be hard and the bedclothing light, and the water should not be allowed to accumulate in the bladder. If these precautionary measures prove inadequate, they can be supplemented with great advantage by the use of suppositories of camphor, opium, and lupulin (camphor, grains iv; opium, grains ij; lupulin, grains xv; oil of theobroma, q. s. ut ft. suppos.). One of these introduced at bedtime will greatly moderate, if not prevent, the attacks.

An obstinate chordee is resolved with the least delay by plunging the penis into ice-water or surrounding it with an ice-bag. No attempt should be made to subjugate the rebellious organ by forcible bending or "breaking," as is sometimes practiced. The conquest is gained at too dear a price, as it is liable to be followed by severe hemorrhage into the structure of the cavernous or spongy bodies, with subsequent deformity, and stricture.

Follicular inflammation.—The urethral inflammation extending into the follicles of the canal may excite so much swelling at their orifices as to cause their temporary occlusion. The accumulation of the perverted secretion in the fundus of the glands, together with a plastic infiltration around their circumference, gives rise to small hard nodules, which may be felt through the skin along the urethra. These little tumors pursue one of two courses: either their urethral orifices, after the subsidence of the inflammation, open and allow the contents of the glands to pass out, and the infiltration is absorbed, or they provoke suppuration in the adjacent cellular tissue and discharge externally by ulceration.

These enlargements may sometimes be resolved by applying freely tincture of iodine externally; but, should this fail, an incision of the skin and an excision of the cyst may be required. There is very little danger of implicating the urethra, inasmuch as the internal orifice of the follicle is permanently closed.

Balano-posthitis.—Gonorrhœal inflammation of the urethra may extend to the glans penis and the inner lining of the prepuce, or an inflammation in these regions may exist altogether independent of the former, when it is called a balano-posthitis, or external gonorrhœa. These structures may be implicated separately, constituting a *balanitis* or a *posthitis*, according as the head of the penis or the foreskin is affected. If it were not that the mucous membrane covering the glans penis is hardened by exposure and thereby rendered less impressible to the action of the virus, balanitis would doubtless, in most instances of the disease where no stricture of the prepuce exists, always precede or accompany the urethral inflammation.

The existence of the disease is easily recognized by the itching, pain, redness and excoriation of the glans, the swollen state of the prepuce, and a copious irritating and offensive purulent discharge.

When the foreskin cannot be retracted, the diagnosis is rendered less certain; though, if there is little ardor urinæ, with much preputial swelling and no particular disposition to erections, a balano-posthitis may be inferred.

TREATMENT.—Nothing will more expeditiously remove such a condition than an injection of nitrate of silver (nitrate of silver, grains xx; water, ℥j), thrown in with a syringe between the glans penis and the prepuce, after having previously washed out with warm water all the purulent and sebaceous secretions.

It is seldom necessary to repeat the injection, and, if so, the nitrate of silver can be substituted by either acetate of zinc or acetate of lead.

Inflammation of Cowper's glands.—When the gonorrhœal inflammation passes down to the deep part of the spongy urethra, it extends by continuity of structure into the ducts of one of Cowper's glands, rarely into both. A peri-glandular cellulitis is kindled, and considerable infiltration takes place in the cellular tissue external to the affected gland. This complication has been particularly described by Gubler in his paper on "Diseases of the Urinary Passages."

A sense of fullness in the perineum, tenderness on pressure on one side of the *raphé* a short distance in front of the anus, and a circumscribed enlargement the size of a cherry-stone, which may be discovered by passing the finger just within the external sphincter and pressing it upward and forward, are the symptoms which denote the occurrence of this affection. This swelling may pursue a course like that which has been described as affecting the follicles, undergoing either resolution or suppuration.

TREATMENT.—If there are much tension and tenderness, the local abstraction of blood, followed by hot fomentations and a gentle cathartic, will aid in establishing resolution. If, however, the affection manifests no amendment, it will probably terminate in the formation of abscess, an event which is announced by a diffused fullness, induration, and throbbing in the perineum, accompanied probably with a rigor.

The presence of these phenomena indicates the necessity of poultices, to

favor an event which cannot be avoided. As the resistance offered by the deep triangular ligament and the middle perineal fascia opposes the passage of the inflammatory products towards the surface, an early incision is demanded, that the tissues may be unloaded and the danger of urinary fistula averted.

Prostato-cystitis.—When a gonorrhœa has been injudiciously managed, either by the premature use of injections or by abortive plans of treatment, or where there have been intemperate excesses on the part of the patient, the inflammation is liable to extend into the prostatic portion of the urethra and the adjacent part of the bladder. The extension of the disease to these portions of the urethra and bladder occasions a frequent desire to urinate, a burning pain along the entire course of the urethral canal during, and particularly severe after, urination, and a constant sense of fullness deep in the perineum, as though some foreign body was lodged in the lower part of the rectum. The discharge in these cases is often greatly diminished.

TREATMENT.—This should be decisive, otherwise a very troublesome chronic inflammation or an irritable state of the bladder may be left, from which the patient will ever after suffer. The recumbent position, with the hips elevated, must be rigorously enforced, and the perineum be freely leeches. To quiet the muscular walls of the bladder, suppositories of opium become invaluable, and, to obtain their best effects, require to be used two or three times a day, aided by the use of hot hip-baths. The urine is to be maintained in a bland state by the free use of alkaline diluents.

Retention of urine may have both a spasmodic and an inflammatory origin. When from the former cause, it comes on suddenly, is intermittent, the patient being able to pass his water one hour and the next unable, and is sometimes preceded by a degree of urethral irritability which causes an involuntary escape of urine. The hot hip-bath and an injection of laudanum and starch-water will afford the necessary relief, and only when these fail is it necessary to employ the catheter. Inflammatory retention requires the same management as prostato-cystitis.

Hemorrhage is occasionally seen to follow a violent chordee, from the rupture of the small vessels of the canal, and is rarely profuse. When sufficiently free and protracted to cause uneasiness, it can be arrested by cold. Only when very obstinate will it be proper to introduce a catheter and employ pressure.

Peri-urethral abscess.—Inflammation of the cellular tissue exterior to the urethra is very common in cases of gonorrhœa, but it generally disappears with the decline of the urethritis. When, however, the inflammatory action, in consequence of mismanagement or from intrinsic peculiarity in the tissues themselves, becomes intractable, it may terminate in suppuration. There are two situations where the accident is prone to occur,—at the navicular fossa and near the bulb of the spongy body. In the former locality the sign of the abscess is a hot, painful swelling at the frænum præputii. It may open externally or internally, and in the former case is liable to leave a suppurating pouch or sac difficult to be healed.

When the abscess is located in the bulbous part of the corpus spongiosum, the pus, guided by the middle perineal fascia, will travel into the scrotum and perineum, and, if the nature of the trouble is not understood, may give rise to the most disastrous consequences.

A wealthy lumberman from the northern part of Pennsylvania came to Philadelphia on business connected with his calling. He was a magnificent specimen of a stalwart woodsman. During his stay in the city, and after perhaps a too free indulgence in wine, he was induced, in company with some boon companions, to resort, for the first time in his life, to a disreputable house. Forty-eight hours after exposure the signs of urethritis began to appear, and very soon ripened into a violent gonorrhœa. The virulence which the disease assumed created alarm in the mind of his medical attendant, and I was asked to confer in the case. I first saw the patient on the

fourth or fifth day of the attack. The penis was enormously swollen and œdematous, the discharge thick and bloody, the perineum and scrotum tumid, tense, and full of pus. Severe rigors had been experienced, and the man was quite delirious, with extremely feeble and frequent pulse, a leaky skin, and all the signs of pyæmic poisoning. His wife and family were immediately notified by telegraph of his extreme illness, and barely reached town in time to witness his death.

In cases of peri-urethral abscess, when the preceding inflammation does not yield to antiphlogistic measures, early and free incisions are necessary to empty the tissues of inflammatory products and preserve them from destruction.

Chancre.—A chancre may be concealed either in the urethra or beneath a phimosed prepuce, and may, by the local irritation, scalding, discharge, and swelling, counterfeit both gonorrhœa and balanoposthitis; or both diseases may exist together. Division of the contracted prepuce will reveal the exact condition of the parts, and, if both are found to be present, each should receive specific treatment.

Herpes præputialis.—This appears as a crop of vesicles around the margin of the foreskin; after the vesicles rupture and their contents escape, there is apt to be left a chapped or excoriated state of the skin, which becomes incrustated with the discharges from the abraded surface.

Bathing the parts in hot water and applying the oxide of zinc ointment, or dusting with calomel, constitute the means of relief.

Bubo.—The inguinal lymphatic glands are liable to become enlarged in gonorrhœa, either from the propagated lymphitis or from sympathy. The enlargement is generally on one side only, and does not often end in supuration.

Rest and lotions of lead-water and laudanum are usually sufficient to disperse the swelling, and if the adenitis does not yield to such applications a blister will probably determine the resolution.

When signs of suppuration appear, the process should be favored by poultices, and as soon as the abscess is matured it should be opened.

Embolism of the dorsal vein of the penis, though extremely rare, has occurred. It is the result of phlebitis or of peri-venous inflammation. The existence of the affection may be discovered by the presence of a hard, tender cord under the skin in the line of the dorsal vein. As the mischief is done before it is likely to be detected, the cure may be left to natural processes. When the tenderness continues along the course of the obstructed vessel, indicating some lingering inflammation in the cellular tissue around the vein, a narrow strip of vesication over the sensitive point will be productive of relief.

Epididymitis and orchitis are quite frequent complications of gonorrhœa, occurring in about thirteen per cent. of all cases of the disease. This affection is rarely witnessed earlier than the second week, and is in most instances a sequel rather than a concomitant of gonorrhœa, induced by cold, venereal excesses, and intemperance, the inflammation of the canal not having been entirely eradicated. When it appears early in the progress of gonorrhœa, it can usually be referred to injections used prematurely or of too great strength.

The statistics of Fournier, Le Fort, and De Castelnau all show that the disease is most frequently encountered about the end of the first month succeeding the appearance of the urethritis. When the inflammation attacks the epididymis the discharge from the urethra frequently ceases, beginning again when the former is relieved.

Though the inflammation begins in the epididymis, it frequently extends to the testicle. It is not to be supposed that the inflammation reaches the organ by being propagated along the long stretch of intermediate mucous membrane between the urethra and the gland. There is between individual members of the same system, though diverse in function, a common bond of sympathy, established through the distribution of nerves, by which one

organ, even though far removed by space, may participate in, or be influenced by, the suffering of another. It is through this peculiar kind of kinship that we explain the occurrence of gonorrhœal epididymitis.

The treatment proper to the disease will be described under affections of the testes.

Consequences of Gonorrhœa.

In addition to the complications which have been noticed, gonorrhœa is not unfrequently followed by *gleet*, *ophthalmia*, *rheumatism*, and *irritable bladder*.

GLEET.—When the acute inflammation of a gonorrhœa has been badly managed, it is liable to degenerate into a chronic state, or into what is generally known as *gleet*,—a condition which often taxes the patience and skill of the surgeon and occasions no small degree of mental anxiety on the part of the patient.

In *gleet* the discharge is very small in quantity, noticed chiefly in the morning and evening, has a viscid, glairy, bluish, or slightly yellow appearance, glues the lips of the meatus together, and leaves a slight stain on the linen of the patient.

Frequently the urethral discharge is so slight that it is made apparent only by pressing it from the deep parts of the penile urethra with the fingers, or only a single drop of mucus and pus may be found occupying the meatus, a condition sometimes described as *pin-head gleet*.

Weeks may elapse without any external manifestation of the disease, yet the exhaustion of a long walk, the congestion attending coition, or indulgence in wine or other stimulating drink will call into activity the latent inflammation and cause for a few days a considerable increase in the discharge.

The structural alterations which cause and perpetuate *gleet* are fourfold: first, it may depend on one or more spots of congested or chronically inflamed mucous membrane, in which condition there is usually some sign of submucous thickening, or, secondly, on the presence of one or more patches of granulation-tissue, in most respects like those which are seen on the inner surface of the eyelids in certain forms of conjunctivitis; thirdly, it may arise from inflammatory thickening, as in stricture; and, fourthly, it may be the result of a chronic folliculitis.

The portions of the urethra which are generally implicated in *gleet* are the fossa navicularis and the deep portion near the bulb of the corpus spongiosum. There is some difference of opinion in regard to the contagious property of the discharge, some alleging that it is entirely innocuous and incommunicable when applied to the mucous membrane of the genital organs. This is unquestionably erroneous: so long as an individual labors under any discharge, however slight, which contains pus, he is liable to communicate a gonorrhœal urethritis in coition.

TREATMENT.—Before commencing to treat a patient for *gleet*, a very careful examination should be made into both the history of the case and the actual appearance of the discharge.

Not a few persons allow themselves to be victimized by their own ignorance, or by the ignorance and unprincipled representations of charlatans.

It is quite common for young men to apply for relief when only a little glairy mucus is discovered in the orifice of the urethra, and this present only when there has existed some previous sexual excitement,—a condition which merely indicates a temporary physiological activity of the follicles of the mucous membrane of the urethra, and which is entirely natural and consistent with a healthy condition of the canal.

Other persons, peculiarly sensitive and apprehensive, after having had an attack of gonorrhœa, notwithstanding that the disease may have been treated with unexceptionable skill, are constantly “milking” the penis to see if some trace of the discharge may not be discovered. This very common practice seldom fails to supply what is so officiously sought after. The same manipu-

lation will rarely fail to excite a flow of the ordinary mucous secretion in the urethra of one who has never suffered from gonorrhœa. Besides, it must not be forgotten that for some time after an attack of the disease has passed away the mucous membrane remains in a supersensitive state and intolerant of such violence as this rude handling must inflict.

Again, there are delicate, pale, lymphatic young men, who, from an impoverished condition of the blood and a general state of relaxation, may be annoyed by a thin mucous discharge long after a gonorrhœa has disappeared, or even when no disease of the kind has existed.

The foregoing considerations are consequently quite important to the proper understanding of the true nature of urethral discharges, and in such cases a few words of explanation and friendly counsel will allay the groundless apprehensions of the patient and restore his peace of mind and usefulness.

The next important point is to ascertain the morbid condition on which a gleet discharge depends, and for this purpose it is necessary to make an exploration of the urethra. If the discharge is an old one, there will be reason to suspect the presence of stricture; and this must be determined by passing along the canal a soft bougie having a bulbous extremity.

If the subject of stricture is eliminated from the diagnosis, or if the gleet is of recent standing, it will most probably depend on a localized congestion of some spot at the anterior or posterior point of the penile portion of the urethra, which may be detected by passing slowly along the canal a good-sized metallic bougie. Contact of the instrument with such a patch will extort some expression of pain or uneasiness from the patient, and the diagnosis will receive further confirmation if, by external pressure over the suspected spot with the fingers while the bougie remains in the canal, tenderness is found to exist.

Granular urethritis seldom occurs as a recent lesion. It is, however, almost always present when the disease has existed for three or four months, and is, I believe, a more common cause of gleet than is stricture. The endoscope has been employed to ascertain both the seat and the nature of the cause keeping up the discharge, and also for the purpose of applying remedies directly to the spot; but in my hands the instrument has proved exceedingly unsatisfactory.

TREATMENT.—When the suspicion of stricture has been verified by a physical exploration, its treatment must take precedence of all other measures; and when this has been brought successfully to a termination, the gleet usually disappears.

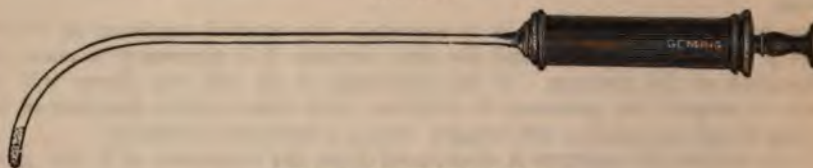
When the case depends on one or more spots of local congestion, it may frequently be cured by deep injections, preserving the urine in an alkaline state, avoiding stimulants and sexual intercourse, and toning up the general system if there is evidence of weakness or enfeebled health. The injections as they are often employed are prejudicial, on account of their strength and the manner in which they are used. It is imagined that, inasmuch as the disease is a chronic one, they should be strong and frequently changed. As they are introduced into the canal in the ordinary manner, the entire mucous surface, sound as well as diseased, is subjected to unnecessary irritation, and frequently the injections do not reach the affected part of the urethra at all. The substances which may be employed with the greatest advantage as injections are sulphate of zinc, acetate of lead, nitrate of silver, persulphate of iron, permanganate of potash, and the compound solution of iodine. The first two agents rarely require to be used stronger than in the proportion of two or three grains to the ounce of water, and the third not exceeding two grains to the ounce of water. The formula for the persulphate of iron and the permanganate of potash is half a drachm of either to six ounces of water, and for the iodine, five or ten drops to the ounce. Once a day is sufficiently often to use such injections.

Alkalinity of the urine must be maintained by the daily use of diluents

containing bicarbonate of soda or of potash. The internal exhibition of balsam copaiba is not contra-indicated in gleet, but, on the contrary, is highly advantageous so long as no gastric distress occurs. I believe that in this affection, as well as in acute gonorrhœa, this article possesses properties which render it preferable to either cubebs or yellow oil of sandal-wood.

If, after two or three weeks have elapsed, no progress has been made towards the cure of the disease, it will be proper to resort to deep injections; and these should be made preferably by the surgeon himself. The instrument for the purpose is a syringe holding one drachm, and having a long, very slightly curved nozzle with a number of very small openings near its free extremity. (Fig. 1268.) After charging the instrument with a solution of

FIG. 1268.



Syringe for deep urethral injections.

nitrate of silver (grains ij of the salt, \mathfrak{z} i of distilled water), the long canula-point is cautiously passed down almost to the termination of the penile urethra, and its contents gently discharged into this portion of the canal, a finger being at the same time pressed immediately behind the scrotum and there held for two or three minutes after the withdrawal of the syringe, in order that the fluid may be retained in this part of the tube until the mucous surface has been thoroughly medicated.

When this has been effected, and without removing the post-scrotal pressure, an ordinary penis syringe filled with warm salt water or flaxseed-tea must be discharged into the urethra, when the fingers may be taken away and the liquids allowed to run out together.

In this way the affected surface may be treated with a strong solution of nitrate of silver and the rest of the mucous membrane at the same time receive protection by the dilution effected by the second injection. This procedure may be repeated two or three times a week. Blistering the external surface of the urethra has been extolled by Milton; and when the gleet depends on inflammation in the urethral lacunæ, and the vesication is repeated, it certainly does exert no small influence in eradicating the disease. Professor Gross advises, in similar cases, the use of tincture of iodine frequently brushed along the under surface of the penis.

When the patient's general health is below the proper standard, the local conditions will be greatly benefited by constitutional remedies, such as tincture of sesquichloride of iron, quinine, extract of malt, cod-liver oil, red wine, moderate exercise in the open air, and sea-bathing.

Granular gleet is the most incorrigible and provokingly obstinate of all forms of the disease. It is useless to speak of dealing tenderly with so stubborn an affection. Whether the granulations are few or many, the topical applications must be potent,—nitrate of silver or sulphate of copper being among the best, and of a strength of not less than sixty to one hundred grains to the ounce of distilled water.

There are several ways of applying these remedies. I employ very frequently an instrument which consists of a straight tube with a closed and rounded extremity near which are two elongated fenestræ. In this tube runs a stylet or porte-caustic charged with the solid nitrate of silver. (Fig. 1269.)

To make the application, the instrument is passed down the urethra, pressure being made on the outside with a finger until the diseased surface can

be located by the uneasiness experienced by the patient, when, by turning the stylet bearing the caustic, the latter is brought opposite the fenestra. If the instrument is now turned in the urethra, the granulations can be cauterized, after which, by reversing the movement of the stylet, the instrument may be withdrawn without touching any other part of the canal.

FIG. 1269.



Instrument for local cauterization of the urethra.

A less decided impression may also be made by a dossil of absorbent cotton attached to a stylet and concealed within a hollow, catheter-shaped tube. (Fig. 1270.)

FIG. 1270.



Instrument for cauterizing limited districts of the urethra.

This will allow of a direct application to the affected surface without touching other portions of the canal. The instrument is carried along the urethra until the offending point is reached, when the cotton, previously saturated with the liquid, is pushed forward and turned round by the stylet two or three times, thus cauterizing the diseased surface, when it is again drawn into the tube and the latter removed from the canal.

A second plan is by introducing an ordinary endoscopic tube, bearing an obturator to admit of its harmless admission, and, after reaching what is believed to be the diseased point, removing the obturator and touching the part with a dossil of cotton attached to a long wire or probe: this may be repeated twice a week for four or five applications, after which the usual weak injections may suffice to complete the cure.

It is in such cases that the endoscope has been lauded, particularly by Desormeaux, as being peculiarly useful in disclosing the granulated or diseased surface and offering a convenient medium for local medication. I must confess that, after considerable practice in the use of the instrument, I have never been able satisfactorily to distinguish between the diseased and the healthy urethra. The mucous membrane which appears at the end of the tube in a few moments becomes congested by crowding against the margin of the instrument. It is possible, however, that my failure is due to the absence of that deft manipulation which belongs to the distinguished inventor of this ingenious mechanism.

A third method of cauterizing the granulations, when the latter are believed to be widely disseminated, is, after introducing the long probe containing the cotton charged with nitrate of silver through the tube, to remove the latter, letting the little swab remain, which may then be withdrawn, in doing which no part of the mucous membrane will escape being cauterized. It is rarely necessary to resort to so heroic a plan of treatment, and, when so, the redundant caustic should be immediately neutralized by an injection of a weak solution of salt and water.

The introduction of sounds, plain or medicated with various ointments, is frequently practiced. As ordinarily employed, they are capable of doing little else than harm, by irritating the surface of the urethra; but, used in the manner I shall direct, they are very important adjuvants in the treatment of granular gleet. The instrument, which should be a metallic one and in size almost equal to the full capacity of the canal, should be carried through the penile urethra, and there retained for an hour, if the patient can endure its presence. The operation may be repeated three or four times a week. It acts much in the same way as strapping does in repressing the redundant granulations of an ulcer and favoring cicatrization.

Various medicated bougies have been devised, by diffusing astringents, such as zinc, tannin, lead, copper, and other substances, through a solution of gum tragacanth, and allowing it to harden in moulds. These are introduced into the urethra and allowed to dissolve slowly in the canal. I have not been favorably impressed with their use.

GONORRHOEAL OPHTHALMIA begins as a conjunctivitis, the result most probably of inoculation by the purulent matter coming in contact with the palpebral or ocular conjunctiva. It is a formidable malady, and frequently results in complete disorganization of the eye and loss of vision. Hence the importance of communicating to patients suffering from gonorrhœa the necessity of observing the utmost care and cleanliness, and of always washing the hands after handling the penis. The subject will be treated of under the head of diseases of the eye.

GONORRHOEAL RHEUMATISM.—This affection, first noticed coincidently by Selle and Swediaur almost a century ago, makes its appearance generally during the acute stage of gonorrhœa, though it may occur at a later date. Women are singularly exempt from the disease. Its invasion is usually sudden, and it may either select the synovial membrane of the joints, preferably the knee, elbow, or ankle, or may expend its violence on the fibrous and bursal structures. In the latter form, resembling in its behavior ordinary rheumatic inflammation, several joints may be simultaneously attacked; the muscles and their tendons, the sheaths through which they pass, the bursal sacs, and the nerves also suffer. Even the sclerotic coat of the eye, and the iris, may become involved. When gonorrhœal rheumatism attacks the synovial membrane of a joint, though there may be little pain and an entire absence of surface redness, there will generally be a considerable effusion into the cavity of the articulation, which is removed with no small difficulty. When more widely distributed, affecting several joints at the same time, or the contiguous muscles with their tendons, the tenderness and pain equal in severity those of ordinary acute rheumatism, and are attended in most instances by some fever, which, however, is transient, rarely lasting over five or six days. The subsidence of the constitutional disturbance does not appear to affect the local symptoms in any way, the suffering continuing about the same, or perhaps being even increased in severity.

Little is known of the true nature of the disease. The doctrine of metastasis receives little or no support from the urethral conditions, as the appearance of the rheumatism is neither preceded nor followed by any diminution in the amount of the discharge or by any visible alteration in its quality. Nor is the supposition of a previous rheumatic diathesis entitled to any higher consideration. In a number of cases which I have seen, no such connection could be traced; on the contrary, the patients were all quite young, with a single exception, and had been remarkably free from muscular pains or stiffness of the joints. The most plausible theory is the *septicæmic*, according to which there are introduced into the circulation certain poisonous matters which give rise to the general and local disturbance.

Between ordinary rheumatism and that arising from gonorrhœal causes there are several notable differences, which prove a difference in origin of the two affections. They may be contrasted as follows:

GONORRHOEAL RHEUMATISM.

Previous existence of a purulent urethral discharge.

Constitutional disturbance transient, and never very acute.

Fixed, with little tendency to change its locality.

Females rarely, if ever, affected.

Tendency to become multilocalized not marked.

Little tendency to cardiac complications.

COMMON RHEUMATISM.

No urethral discharge.

Constitutional disturbance often severe and prolonged.

Frequently shifting from joint to joint.

Females suffering with almost the same frequency as males.

Several joints frequently attacked at the same time.

Marked tendency to cardiac complications.

With regard to the last differential peculiarity, that of cardiac complication, La Cassagne and one or two other writers speak of endocarditis following an attack of gonorrhœa; but their experience does not accord with that of the majority of observers.

TREATMENT.—The disease, as a rule, yields very slowly and reluctantly to treatment. If it assumes the articular form, the joint must be placed in a state of perfect rest, and, if very tender and painful, a few leeches should be applied. In the absence of leeches, or even after their use, blistering the surface of the articulation will be productive of decided relief. As soon as the tenderness has somewhat abated, pressure should be applied with an accurately-adjusted roller. The bowels are to be kept open, and the kidneys should be acted upon by diuretics, such as acetate or nitrate of potash, while rest is to be procured by the occasional use of Dover's powder. When the disease involves the muscular and fibrous structures, iodide of potassium will afford some relief, assisted by frictions with anodyne liniments. In case the eye becomes affected, small doses of bichloride of mercury should be associated with the iodide of potassium, a blister should be applied to the temple, and the iris should be protected by the local use of atropia. The local treatment of the gonorrhœa must not be suspended while that for the rheumatism is being carried on, but should be conducted without any reference to the latter.

IRRITABLE BLADDER is one of those sequels of gonorrhœa which follow cases in which the prostate or the neck of the bladder has participated in the inflammation. It may continue for a long time and prove to be a very troublesome condition.

The patient is harassed with a frequent desire to micturate, and compelled to empty the viscus many times during the day and night, in some instances every half-hour. The urine remains perfectly clear, though, when the irritability is not relieved, it finally becomes cloudy. Severe and painful vesical tenesmus following each micturition is not an uncommon accompaniment of the affection. There is often a neuralgic element present, which aggravates the patient's distress.

TREATMENT.—As long as there is no muco-purulent deposit in the urine the case may be regarded as purely one of irritation, uncomplicated by inflammation. Alkaline diluents must be prescribed, with anodyne suppositories, and the use of the cold hip-bath. Quinine and extract of hyoscyamus will also prove useful; and the patient must be urged to pursue a systematic method of urinating, to resist the inclination to empty the bladder, and, by thus gradually prolonging the periods between the micturitions, to acquire a voluntary control over the viscus. The diet must be of the most unirritating character, though nutritious, and all stimulants should be forbidden.

Neuralgia of the Urethra.

Neuralgia of the urethra cannot be considered by any means common as an idiopathic affection of the urethra, though it frequently exists secondarily to some prostatic, vesical, or renal irritation, as the presence of a calculus in lithiasis and oxaluria, or a congested state of the prostate body.

It is often witnessed in connection with anal fissure, both in the male and in the female, and in the latter may be connected with some disturbance of the menstrual function. When the neuralgia cannot be traced to some one of these causes, it is most probably referable to masturbation, sexual excess, or miasmatic influence. No period of life confers exemption from the disease, though it is most common in the young. The attacks are usually sudden, though sometimes preceded by a sense of weight or fullness of the penis. The pain is darting, intermittent, and may extend beyond the limits of the urethra, shooting up to the bladder, the rectum, and even along the inside of the thighs. Seldom does it continue for any length of time without creating the desire to urinate, followed by more or less burning or scalding sensations along the whole length of the urethra. The attacks go and come at uncertain intervals, or they may recur with considerable regularity.

TREATMENT.—The treatment must be based on an intelligent understanding of the cause, and, when this can be discovered, its removal must be the first step towards effecting a cure. If a foreign body is detected in the urethra or in the bladder, it must be removed. If the disease results from some vice in the urinary secretion, that will demand correction. If it proceeds from fissure of the anus, the division of the muscle will be required. When there is reason to believe that it has a uterine origin, remedies addressed to that organ will be necessary; and if from sexual excesses, abstinence must be enjoined.

The remedies which promise a cure in uncomplicated cases of urethral neuralgia are quinine and arsenic, administered in full doses, and, if the patient is at all reduced in general strength, iron, the cold hip-bath, flagellation of the hips, a chaste life, and out-door exercise will materially aid in removing the disease. When it is miasmatic in its origin, full doses of quinia, with piperine, constitute the most efficient remedies. To shorten or alleviate the suffering during an attack, hot hip-baths and suppositories of opium should be ordered.

Stricture of the Urethra.

By stricture of the urethra is understood a permanent loss of the dilatability of the urethral canal, in consequence of inflammatory alterations in its structure. These alterations, whereby the urethral canal is so narrowed as to offer an obstacle to the passage of instruments and to the escape of urine, may have either a *traumatic* or an *idiopathic* origin. The traumatic form of the disease is produced either by internal or by external violence. As illustrative of this point may be mentioned the improper or rude use of bougies, catheters, or other instruments, and the introduction of foreign substances, either from without or from the bladder. Examples of external violence are falls upon the perineum, kicks, and shot wounds received on the under surface of the organ. By far the most common causes of stricture are gonorrhoeal urethritis and the injudicious employment of injections.

During the late American war there were reported 2581 cases of stricture of the urethra. The records also show that there were among the white and colored troops 102,893 cases of gonorrhoea. Considering the infrequency of shot wounds of the penis, a very small number of these strictures must have had a traumatic origin, so that it is fair to infer that an overwhelming proportion may be justly placed to the credit of venereal disease. The less common causes of urethral stricture are sexual excess, masturbation, and chancre.

Spasmodic stricture, which is retained by some writers as one of the divisions of this disease, is only a temporary and incidental narrowing of a section of the canal, the result of muscular spasm from a pre-existing local irritation, and should not be admitted as one of the forms of this affection. The same may be alleged of the so-termed inflammatory stricture, in which there is a temporary swollen state of the mucous membrane of the urethra, notably

that of the prostatic portion, and which subsides in a short time, leaving the tissues as sound as before its occurrence.

Stricture of the urethra is almost exclusively a disease of the male, a sexual distinction which is due to the length and the exposed situation of the canal, and to its relation to a large amount of erectile tissue, by which it is rendered liable to injury and to inflammatory changes.

Position of strictures.—Any portion of the urethra, except the prostatic, may be the seat of stricture; but there are certain tracts in the course of the canal which are more frequently affected than others, as the last half-inch of the penile urethra, the anterior half of the membranous portion, the first inch posterior to the external orifice, and the middle of the canal. Very careful observations have been made by Sir Henry Thompson, Professor Otis, and Dr. S. W. Gross, and the results of the labors of these different gentlemen vary somewhat as to the relative frequency of coarctation in the specially vulnerable parts of the canal. For example, Sir Henry Thompson examined 270 preparations, or 320 strictures, among the pathological collections in Great Britain and on the Continent. Of this number, 215 were found at the termination of the spongy and in the commencement of the membranous portions of the urethra (67 per cent. of the entire number); 54, or 17 per cent., at the anterior extremity; and 51, or 16 per cent., at the middle of the spongy urethra. Professor Otis, whose observations were made on living subjects, found 258 strictures in 100 persons: 163, or 63 per cent., occupying the anterior portion of the canal; 81, or 31 per cent., the middle; and 14, or only 5 per cent., the membranous portion. Dr. S. W. Gross found, in examining 100 living persons, 173 strictures: 76, or 43.93 per cent., located in the posterior region; 48, or 27.74 per cent., in the middle region; and 49, or 28.32 per cent., in the anterior region. A very large proportion of all the strictures which have come under my observation, both in private and in hospital practice, have been seated in the terminal portion of the spongy and in the front part of the membranous urethra.

Strictures are either *solitary* or *multiple*, the former being much the more frequent. In multiple stricture I have rarely witnessed more than four, though instances are recorded of six, eight, and eleven, and in one case mentioned by Professor Otis there were fourteen. It is asserted that anterior strictures are rarely single, and that the presence of one in this part of the urethra betokens a similar coarctation in the posterior portion of the canal,—an observation which my own experience amply verifies.

Strictures are rarely met with in persons under twenty-five years of age, unless as a result of traumatism. Professor Ashhurst met with a case of fatal urinary extravasation, from the urethra giving way behind a close stricture, in a lad eleven years of age. I successfully performed perineal section for the cure of urethral fistula following stricture in a boy of fourteen in the Pennsylvania Hospital.

Classification.—Seizing on some peculiarity in sensibility, degree, physical quality, origin, age, resistance, or form, writers have constructed a classification as formidable to contemplate as it is useless in practice. Thus, we have irritable stricture, partial and complete, soft and callous, elastic and non-elastic, traumatic and idiopathic, recent and old, permeable and impermeable, linear, annular, regular, and bridle strictures, together with many others of less imposing designations. In almost all urethral coarctations of the nature of true stricture the obstruction consists either of false bands stretching across the canal, or of plastic deposits in the submucous cellular tissue, causing circumferential induration; or both conditions may exist together. Accordingly, a very simple division of the subject is into the *membranous*, *indurated*, and *mixed* strictures.

In the first, or membranous variety, the band may be a single crescent-shaped membranous fold, limited to one side of the canal, or it may encircle the latter, forming a circular valve with a central opening, which has been not inaptly compared to the pyloric orifice of the stomach; or the bands may

be multiple and intersecting, giving a reticulated appearance to the affected portion of the urethra. A third variety is occasionally met with, in which there appear in the urethra a series of fan-like plications radiating from a central white scar.

In the second variety, the induration which constitutes a dominant feature of the stricture may be limited to the cellular and muscular tissue im-

mediately underlying the mucous membrane of the canal, or it may include, when seated in the spongy urethra, the erectile tissue, and, in some old, incurable cases of the disease, even the fibrous membrane of the corpus spongiosum. The circular disposition of the induration forms the *annular* stricture of the urethra.

In the mixed form, the characteristics of both the membranous and the indurated stricture are found conjoined. Examples of the two varieties of stricture are represented in Figs. 1271 and 1272.

PATHOLOGY.—Though the existence of urethral stricture was well known to the ancient body of physicians, they were entirely ignorant of the nature of the anatomical changes which occasioned the obstructions. About the latter part of the seventeenth and the beginning of the eighteenth century the subject began particularly to attract the attention of writers,

among whom were Pietre, Ledran, Goulard, Arnaud, and several others, and, still later, John Hunter, Sir Everard Home, Desault, and, more especially, Benjamin Bell.

In idiopathic stricture the initial step in the formation of the disease is a localized chronic urethritis. After the acute inflammation of the mucous membrane of the canal has disappeared, there remains at some point in the course of the chronically-inflamed urethra a patch, which, under the irritating influence of the urine and the repeated congestions attending erections and sexual indulgence, continues to linger without particularly attracting the notice of the patient,—it may be, without his knowledge at all. Often the only evidence of there being anything wrong in the canal is the existence of a gleet. This local inflammation is accompanied by a submucous infiltration of cell-forms and plastic lymph. These cells, partly emigrants and partly derived from the anatomical components of the parts, become gradually transformed into connective tissue, on the amount and maturity of which depends the surrounding induration. During the progress of this submucous new formation all distinction of tissue is frequently lost, the mucous membrane and the cellular and muscular structures all becoming blended into an indistinguishable mass of connective tissue, having marked cicatricial properties, and seriously diminishing the elastic and voluntary contractility of the canal, in consequence of which the last drops of urine are not promptly expelled. When granulations have existed, a more or less gleet discharge will always be present: indeed, a granular condition of the urethra is regarded by Desormeaux as an invariable antecedent and accompaniment of stricture,—an opinion, however, in which I do not concur. There are many cases of stricture in which not a trace of discharge has been noticed from the time

FIG. 1272.



Indurated stricture.

FIG. 1271.



Membranous stricture.

the gonorrhœal inflammation disappeared until some difficulty in micturition was observed, a period often of several years.

A stricture once formed is constantly liable to acute attacks, which are accompanied by additional accumulations of new inflammatory products, and these in turn undergoing organization enlarge the sphere of induration, encroaching more and more on the lumen of the canal and correspondingly detracting from its dilatability.

SYMPTOMS.—Among the earliest signs of urethral stricture are the presence of a slight discharge from the urethra and some trouble experienced in micturition.

The amount and character of the discharge are subject to great variations. It may not exceed a single drop, gluing together the sides of the meatus, or it may be sufficiently free to lead to the suspicion that gonorrhœa has been again contracted. In other instances the only evidence of anything abnormal is the presence in the urine of little shreds of mucus.

The inconvenience experienced in urination consists in increased frequency of micturition, the bladder being emptied at short intervals through the day, and frequently during the night. The stream is diminished in size, force, and velocity, and, as it lessens, the power to expel it with vigor is correspondingly lost; as the obstruction increases, it becomes small, forked, twisted, or divided into several small branches, until finally it may end in dribbling, or escape only in drops, requiring for its expulsion severe straining, followed by smarting and pain. Frequently the patient is obliged to stand for some time making ineffectual efforts to relieve the bladder, and is compelled to wait for a still longer period in order to discharge the last drops from the canal. In aggravated cases, the forcible efforts which are necessary to empty the bladder are liable to produce hemorrhoids, hernia, and prolapsus of the rectum, and with the latter, not unfrequently, the escape of fecal matter. Pain and uneasiness are also experienced in the perineum, through the testicles, in the groins, and around the hips. The constant irritation occasioned by the mechanical occlusion of the urethra, with the concomitant difficulty in micturition, keeps the penis often in a state of passive congestion, provoking painful erections and nocturnal emissions. The same obstacle which prevents the flow of the urine resists the escape of the semen, and consequently the sufferer is annoyed with the slow escape of the secretion during the day. The urine, after a time, becomes altered in appearance, partly from the local irritation at the seat of the stricture being propagated to the bladder, and partly from the inability completely to discharge the contents of the viscus. The residual urine undergoes decomposition and reacts on the mucous membrane, in consequence of which the water becomes alkaline, cloudy, and ammoniacal, depositing, after standing for some time in a vessel and cooling, a heavy precipitate consisting of the triple phosphate of magnesia and ammonia, together with a ropy muco-pus and vesical epithelium. In addition to these symptoms there may follow irritation or incontinence of the urine. It can be readily conceived that where the lumen of the urethra has been greatly diminished and the parts rendered exceedingly irritable the canal would on slight provocation, occasioned by alteration in the constitution of the urine or by exposure to atmospheric vicissitudes, giving rise to inflammatory or congestive swelling, become so tightly closed as entirely to prevent the escape of urine, and culminate in retention. It is at such time also that incontinence may arise, the latter being related to the former as effect to cause. This incontinence, which is so often spoken of as paralysis, is due either to an over-distended bladder or to so great obstruction that the column of water issuing from the bladder and not being able to escape, except in drops, keeps the neck of the viscus so dilated as to make the action of the sphincter nugatory, and hence the constant dribbling which renders the patient's clothing, bed, and person wet and offensive from the urinous odor.

DIAGNOSIS.—Though the symptoms enumerated, collectively considered,

are sufficient to determine the existence of urethral stricture, the diagnosis may be placed beyond all possibility of error by a physical exploration of the canal. This examination can be conducted with either a metal or a soft bougie. For safety, simplicity, and accuracy the soft bulbous bougie of Leroy d'Etiolles, or the metallic one of Otis, is to be preferred. These instruments have an acorn or olive-shaped bulb attached to a long, flexible shaft. (Figs. 1273, 1274.) Their sizes answer to the number of the scale in ordinary use.

FIG. 1273.



Metallic bulbous bougie.

FIG. 1274.



Soft bulbous bougie of Leroy d'Etiolles.

Before commencing with the exploration, it is a good rule to have the patient urinate. Some estimate of the degree of obstruction may be formed from the size of the stream, and an instrument selected accordingly. It is well to commence with the larger and proceed to the smaller-sized bougies. Selecting one which is deemed of the proper dimensions, it should be oiled, introduced into the orifice of the urethra, and slowly pushed down to the canal until it encounters a positive obstruction. A mark must now be made with the finger-nail on the shaft of the instrument at the meatus, when the bougie can be withdrawn and the distance between its bulb and the mark on the stem measured, which will indicate the distance of the stricture from the orifice of the urethra. This determined, a smaller instrument should be selected, one which can be passed through the constricted portion of the canal and carried onward into the bladder, thus detecting other strictures in its passage if any such exist. The next step is to ascertain the length of the obstruction. In acquiring this information, the bougie, now supposed to be in the bladder, is slowly withdrawn. When the base of the bulb comes in contact with the deep extremity of the stricture it will be momentarily arrested, whereupon a mark should be made on the shaft. Increasing the traction, the contracted portion of the urethra will be distinctly felt by the resistance offered to the progress of the instrument, which suddenly ceases as soon as the bulb has passed the limits of the stricture, which it does with a distinct hitch. If a second mark is now made on the shaft of the bougie, the distance between the two gives the length of the constricted portion of the canal. In connection with the use of the bulbous bougie there is one important fact noticed by Dr. J. William White, of Philadelphia, and demonstrated by him in one hundred examinations of healthy urethras at the University Hospital, and by a series of dissections in the dead-room of the Philadelphia Hospital. There is almost invariably a point in the normal urethra in passing which during the withdrawal of a bulbous bougie the sensation imparted to the hand of the surgeon is precisely similar to that experienced in passing a stricture and is therefore liable to be misinterpreted. This point is situated in the membranous urethra just where it is invested by the posterior layer of the deep perineal fascia; and the arrest of the bougie during withdrawal is occasioned, as was shown by Dr. White, by the hitching of the base of the bulb on this fascia as the instrument passes from the movable prostatic urethra to the more fixed membranous portion.

In the absence of the bulbous instrument the ordinary soft or metallic

bougie can be used in working out the diagnosis of stricture; and in making a selection of the proper number for testing the state of the canal, it is always proper to descend the scale, and not to ascend it, beginning, say, with a No. 18 and then proceeding to those of a smaller size as the case may require. If the meatus is abnormally small, it should be increased in order to allow the passage of a proper-sized bulb. If, after repeated trials, in which the point of the bougie is made to follow different sides of the urethra, the instrument is found to be arrested at the same point, and especially if there is realized a rough sensation, the existence of stricture may be positively affirmed. The endoscope has been employed as a means of diagnosing the presence of stricture, but little assistance can be expected from its use.

For a long time there may be very slight, if any, constitutional disturbance, except, perhaps, when an attack of retention comes on from exposure, when there may occur a brisk chill, followed by fever, hot skin, high temperature, and headache, which, however, soon pass away, leaving the patient much as before the attack. A time comes, however, when the digestive organs become disturbed, followed by loss of appetite, diminished strength, and progressive emaciation. The patient presents a haggard expression, and often suffers from extreme depression of spirits and an utter indisposition to exertion.

Sequels of stricture.—One of the most common results of stricture, as might naturally be supposed, from a column of water being forcibly impelled against an obstruction which allows only a few drops to escape at a time, is a dilatation of the urethra behind the seat of coarctation. This invariably occurs, in obedience to physical laws, at whatever point in the course of the canal the stricture exists. In accordance with the common seat of the disease, this dilatation is most frequently found at the membranous portion of the canal, and gradually implicates the prostatic. The sinus formed in this way becomes sufficiently large to hold several ounces of fluid. If there are multiple strictures, similar enlargements may exist behind each obstruction. The size of the canal is little altered in front of a stricture, though it appears to me that in old cases of the disease the capacity of the tube is somewhat lessened. This might be anticipated when we consider that the column of water which forms in front of a urethral obstruction of this nature is never of the normal size, and that consequently the tendency in this portion of the urethra would be to contract. Instances have been furnished of a dilatation in advance of a stricture; but the phenomenon appears to me to be incapable of explanation according to any law in hydrodynamics.

Rupture.—As an effect of dilatation, the walls of the urethra may become more and more attenuated, until, from inflammation, abscess, and ulceration, an opening occurs; or they may give way suddenly during the straining efforts exercised in micturition, causing, in either event, urinary infiltration and abscess, ending in urethral fistula. This accident usually takes place in the perineal part of the urethra, though the spongy portion may also suffer. Not only is the entire calibre of the urethra expanded, but the lacunæ also participate in the dilatation, giving a reticulated or honey-combed appearance to the mucous surface.

Effects on the bladder.—The constant and forcible contraction of the bladder, put forth with a view to discharge its contents, induces enormous hypertrophy of its muscular coat, giving to the interior of the organ an appearance not unlike that presented by the columnæ carneæ of the heart (Fig. 1275), and as the water in the

FIG. 1275.



Interior of the bladder from a patient who suffered from stricture.

viscus is unable to escape, except in a very slow manner, it reacts against the muscular walls. This struggle between the two forces compels the organ to yield at certain points, giving rise to a sacculated or dilated condition of the viscus.

In addition to the irritation arising from the difficulty of discharging the urine, the walls of the bladder are subjected to another, that incident to the decomposition of the retained water, with the precipitated products, exciting *cystitis*, and favoring the development of calculi. There may be, also, patches of ulceration on the mucous membrane, and abscesses in the walls of the bladder.

Ureters and kidneys.—These parts of the urinary apparatus in old and aggravated cases become involved in the general structural devastation. The inflammation extends by continuity of tissue to the mucous membrane lining these cavities; the accumulation of water in the bladder dams the stream back in the ureters, and they become dilated or sacculated at one or several points in their course; the kidney in turn suffers, the pelvis and infundibula becoming dilated until the entire organ is expanded into an immense cyst filled with urine, pus, and various inflammatory products. The history of such a case is not unfrequently terminated by the development of brain symptoms, occasioned by the introduction into the blood of poisonous urinary products.

TREATMENT.—Although many and important advances have been made of late years in the treatment of urethral stricture, the more recent writers on this subject, like *Acestes* of old, seem to me to have aimed at a mark so far removed from the limits of human possibilities that the result has been failure. The radical cure of stricture I believe to be entirely beyond the reach of surgery, notwithstanding the immense and varied resources at her command. This statement is not made in any spirit of depreciation of the labor of those who have given themselves with singular devotion to this branch of surgery. On the contrary, I both honor and admire the work which they have done; but this conclusion has been reached after no small experience both in private and in hospital practice, and after having patients who seemed to be cured, but who, years after, came back, with a return of their strictures. Experience, therefore, to say nothing of the anatomical peculiarities of the tissue which constitutes the coarctation of the urethra, compels me to speak strongly on this subject; and if it savors of dogmatism, it is that which originates in an honest conviction of the truthfulness of the statement, in maintaining which I find myself in the company of many good surgeons who entertain similar views.

The indications in the treatment of urethral stricture are the restoration of the canal to its normal size, if this can be done without seriously compromising the life of the patient, and the subsequent preservation of its proper calibre. It is necessary, therefore, to have a tolerably accurate notion of the exact size of the normal urethra. There is no doubt that anatomy has been a false light to surgery on this point. Works on anatomy tell us that the size of the urethra varies at different points, the smallest portion being the external meatus, and the largest and most dilatable part the prostatic. The external orifice is stated to be about one-fourth of an inch in diameter, and the largest division of the canal approximately about seven-tenths of an inch in circumference. It does not seem to have occurred to anatomists that there must necessarily be great variation in the capacity of the urethra, corresponding to differences in the size of the penis. It appears to have been reserved for American surgeons to demonstrate several very important anatomical peculiarities belonging to this part of the penis and relating to the capacity of the urethra, and also to formulate certain rules for determining the size of each individual urethra or its average extensibility. Professor Otis, of New York, after making a large number of observations, has shown that there is a uniform relation existing between the circumference of the flaccid penis and that of the urethra. Thus, where the organ measured three inches

In circumference, the urethra in its calibre would be thirty of the French scale; when it was three and a quarter inches, the capacity of the urethra would be thirty-two; when it was three and a half inches, the capacity would be thirty-four, etc. In other words, for every quarter of an inch increase in the circumference of the penis over three inches, there will be a corresponding increase in the capacity of the urethra equal to two millimetres. The same surgeon has devised a urethra-metre, an instrument for measuring the calibre of the urethral canal. It consists of a straight canula, No. 8 size, ending in a number of short metallic bars connected with one another and with the canula by hinges, and which can be either closed or expanded into a bulb-shaped figure by a rod which runs through the canula the entire length of the instrument and is worked by a screw at the handle of the same. A dial-plate, with an index, marked off into millimetres, is also attached to the handle of the instrument. When the urethra-metre is used, a thin rubber sheath is drawn over the extremity of the closed instrument, in order to protect the lining membrane of the urethra. It is then well oiled and introduced into the canal, and the bars expanded to an extent not inconsistent with the free movement of the bulb when carried alternately up and down. The capacity of the urethra will be recorded on the dial-plate

FIG. 1276.



The urethra-metre of Otis.

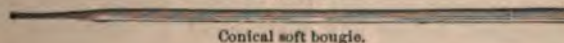
of the urethra-metre in millimetres. (Fig. 1276.) The advantages claimed for the instrument are the knowledge which it supplies of the calibre of the urethra, and of the locality and number of the strictures which may exist, without the necessity of withdrawing the urethra-metre and without reference to the size of the meatus. There can be no doubt that such information will prove of value in the treatment of stricture, as it fixes the extent to which the canal is to be dilated in order to be restored to its original calibre, and accordingly such measurements may be made preliminary to any plan of treatment the surgeon may choose to adopt.

The means employed for fulfilling the indications stated are *dilatation*, *divulsion*, *internal urethrotomy*, and *external urethrotomy*.

Dilatation.—This method is a very old, and, for a large number of strictures, a very satisfactory one. Dilatation may be *gradual* or *rapid*.

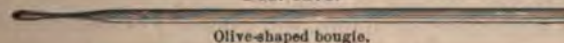
Gradual dilatation is the safest of all measures for the treatment of stricture, and may be accomplished with soft or metal instruments. The soft bougie will be found to answer in a limited number of cases, when, for example, the urethra at the strictured part of the canal is sinuous, or when the calibre of the latter is very small. These bougies are of two kinds, the conical and the olive-shaped. (Figs. 1277, 1278.)

FIG. 1277.



Conical soft bougie.

FIG. 1278.



Olive-shaped bougie.

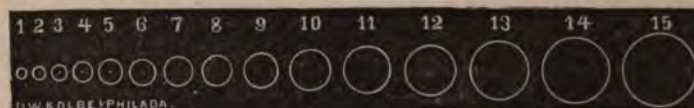
The extreme flexibility of the extremities of these instruments renders them capable of being passed through a tortuous passage which might with a metallic bougie be impervious.

My personal preference, however, after having rendered the route through

the urethra safe by the soft bougie, is for the steel instruments. They should be perfectly smooth, with a stout broad handle, a well-rounded conical point, with a curve similar to that advised for the catheter, and should be nickel-plated, in order to prevent the surface from becoming tarnished by exposure to the air.

They are of graduated sizes, answering to certain scales which have been adopted as the basis for measurement, but which, unfortunately, are not uniform. The English scale contains fifteen numbers (Fig. 1279), the

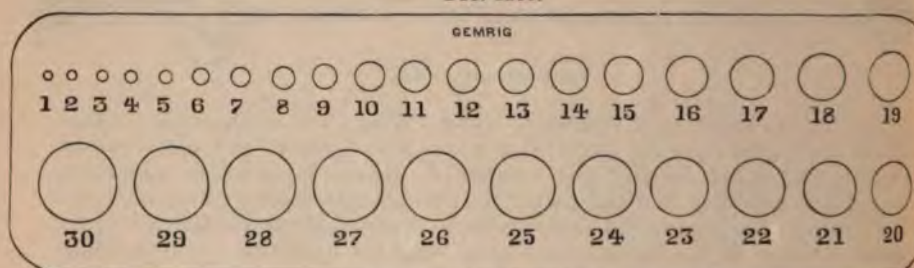
FIG. 1279.



English catheter scale.

increase in size being very considerable between any two numbers. The American scale, constructed on the metric system, is an improvement over the English, the numbers ranging from one to twenty-one, and increasing each by half a millimetre in diameter. The French scale (Fig. 1280) has also the

FIG. 1280.



French catheter scale.

advantage of being much better graduated than the English. It contains thirty numbers, one-third millimetre in diameter being the basis of measurement, and consequently the rise from one size to another is very gradual.

In order to obtain absolute accuracy in the measurement of dilating instruments for the urethra, Dr. Charles Thomas, of Philadelphia, has devised a very simple and at the same time perfectly correct gauge for the purpose, inasmuch as the size is not indicated by arbitrary numbers, but by circumferential or perimetric measurements, expressed in millimetres, as in the French scale. (Figs. 1281, 1282.) It is made from heavy bank-note or bond paper, and is quite durable.

This gauge has a special advantage over all others, in that it is equally adapted for the measurement of instruments of irregular as well as regular form.

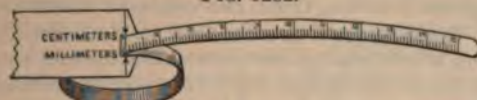
If the stricture is very irritable, the patient should be subjected to some preliminary treatment before any instrument is employed. Twenty-four hours' rest in the recumbent position, one or two warm hip-baths, the absence of all stimulants, the free use of alkaline diluent drinks, and an injection of laudanum, or a suppository of opium, will generally be sufficient to tranquillize the general system and allay the local irritation, when the use of the instrument may be begun.

The recumbent position is the one best adapted for the manipulation. Selecting an instrument larger than is likely to pass the obstruction, carry it, after being warmed to the temperature of the body and well oiled, gently along

anal, until the point becomes arrested by the stricture. If it not pass, let it be withdrawn with the same care as

FIG. 1281.

FIG. 1282.



Thomas's gauge looped, showing mode of application.

observed in its introduction, and a second and smaller-sized

If there is reason to believe that the bougie is not disproportionately large for the coarctated canal, let the operator, should meet with some opposition, not remove the instrument prematurely. Let it be withdrawn and again advanced, and this repeated a number of times. Let the point be directed first in one direction and then in another, and probably, after a few attempts, the difficulty will be overcome and the stricture passed. In the whole procedure very little force is necessary, the requisites to success being patience, gentleness, and a light touch.

Once through the obstruction, the instrument should be withdrawn, the patient remanded to bed, and, if the stricture is an oblique one, a suppository of opium may be introduced into the rectum, and eight or ten grains of quinine immediately administered by the mouth, in order to prevent the occurrence of urethral chill. In three or four days later will be quite soon enough for a second attempt with instruments, and then it is always advisable to pass the smallest instrument introduced, and advance one or two numbers of the scale while sitting, and, if well borne, the operator may proceed more gradually, and allow the bougie to remain in the urethra for a period of ten or fifteen minutes. If little or no irritation has followed the use of the instrument, it will not be necessary to adopt the precautionary measures against urethral chill which were deemed in the first instance. In this manner the dilatation is continued until the normal capacity of the canal is attained. It is probably effected not by stretching alone, but by inducing absorption of the surrounding inflammatory deposits.

After the stricture has been dilated so as to admit a large instrument, the surgeon has another duty to perform, and that is, to instruct the patient in the use of the bougie. Under most circumstances any person of ordinary intelligence and tact can readily acquire the ability to introduce a bougie into his own urethra; but as the tendency to subsequent contraction in all cases of stricture is invariable, it is important that the patient should be instructed before passing from under the supervision of his medical attendant. For this purpose it is not necessary that he should use the largest instrument of the scale. On the contrary, a No. 25* is quite ample for all practical purposes, and should be inserted once or twice a week at first for a few weeks, and afterwards once every two weeks.

A very distinguished authority has advised that in passing an instrument the operator should "forget all about his anatomy." It might be thought to differ from this injunction, and to say that to forget one's anatomy at such a time is to act like a shipmaster who throws away his compass in mid-ocean. The author of that sentiment, although from long and large experience he may not be mistaken, it, I doubt not, owes, I doubt not, his exceptional skill in this department of surgery to the unconscious exercise of what he decries.

Whenever allusion is made in the text to the sizes of urethral instruments, the scale is employed.



Thomas's adaptable metric gauge.

In all cases, then, where dilatation can be effected, that operation, being almost entirely devoid of danger, should be preferred; but there are difficulties which will be frequently encountered in passing a stricture and entering the bladder, from the extreme narrowness or tortuousness or thickening of the diseased part of the channel, and which demand attention. These are embarrassing complications to the young practitioner, but while they are exceedingly troublesome they are not insurmountable. As long as the urine can find its way out through the urethral canal, even though it is only in drops, the route to the bladder in the opposite direction is not impassable by instruments in a skillful and patient hand. This maxim was long ago announced by Syme, and experience has proved its correctness. It would obviously be unsafe to persevere wholly with the metallic bougies under such circumstances.

FIG. 1283.

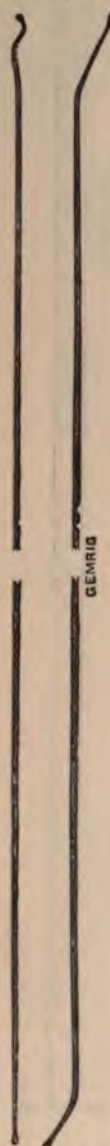


FIG. 1284.



Filiform
whalebone
bougies.

Hollow bougie passed over
the filiform guide.

Filiform instruments of whalebone or of gum (Fig. 1283) will be found of the greatest value.

Whalebone bougies are prepared with straight, angular, or spiral extremities, the points being olive-shaped. They are capital searchers, and can be introduced through a very tortuous passage. The direction of the canal once ascertained, larger instruments can be employed, until the route is made sufficiently capacious and direct to admit of the use of the ordinary hard or soft bougies. But it is even possible to pass a filiform bougie and yet not be able to follow it with another instrument. In such cases we have a valuable resource in the instrument of Professor Otis, which consists of a long, soft, filiform bougie and a hollow metallic instrument similar to a catheter. (Fig. 1284.)

This is one of the safest means of overcoming a narrow or sinuous stricture. A filiform gum bougie eighteen inches in length is first passed along the urethra to the seat of obstruction, when the flexible point usually enters the orifice and glides through the narrow passage into the bladder. The part of the filiform instrument which remains out of the urethra is then passed through the hollow bougie, which, after being introduced into the urethra, is pushed forward over its guide until piloted into the bladder. A repetition of this process will soon remove the embarrassment. This principle of slipping tubes of graduated sizes over a guide previously introduced into the bladder was long ago adopted by Mr. Thomas Wakely, of London (Fig. 1285), and with various modifications has been employed from time to time by

Desault, Buchanan of Glasgow, Maisonneuve, and others.

Sometimes we succeed, when the stricture is seated in the membranous part of the urethra, in getting the point of a bougie engaged, but feel a degree of uncertainty about applying the force necessary to pass the coarctation, for fear the instrument may be deflected from the proper course. In such a strait, a finger introduced into the rectum, and used as a guide, will enable the operator to effect his object with comparative safety. False pas-

sages not unfrequently are a source of deception, by leading the instrument astray. A careful exploration of the urethra will generally enable the surgeon to determine on which aspect of the canal the abnormal opening exists, when it may be avoided by giving the point of the bougie an opposite direction until the region of danger is passed. Another stratagem adopted to overcome the same complication, and practiced by Mercier, is to introduce into the false passage the end of a solid metallic catheter, and then project through its eye, which is placed a short distance back, a second flexible instrument; then, after directing the latter into the true passage, the former can be withdrawn.

There are strictures in which the urethra is traversed by a reticulation of bands, and in which the lacunae become dilated, so that the point of a small instrument is likely to pass into one of these rather than into the proper channel. In such cases these closed cavities or recesses can be filled by inserting a number of filiform whalebones, which will lessen the chances of the bougie missing the normal course.

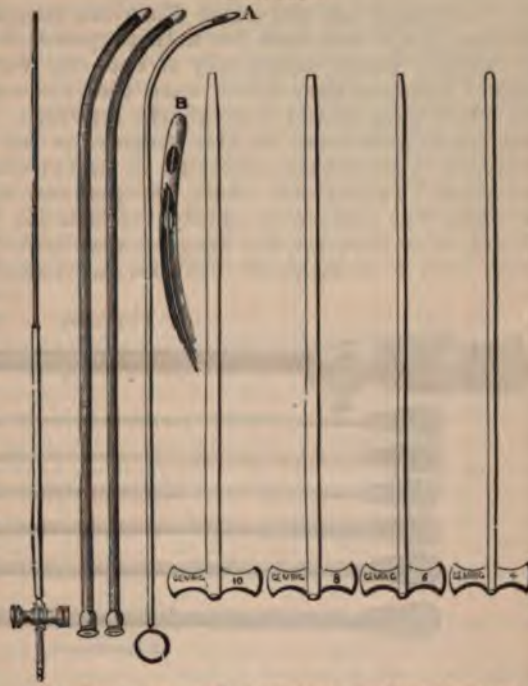
Continuous dilatation may become necessary in cases where the circumstances are such that it is necessary to effect the dilatation in a short time, or where it is found, after each dilatation by the gradual method, that the stricture tends to return to its original size; and here the soft catheter is always to be preferred, provided it can be introduced. Until this can easily be done it is better to postpone a resort to this method.

It is necessary that the patient should be confined to bed during the treatment. The instrument, which should be one that will not fill the stricture tightly (otherwise it will defeat the object by causing irritation, congestion, and greater infiltration), must be passed barely into the bladder, and then secured in position by one of the methods directed for retaining the catheter. The object is not to stretch the coarctation, but to cause the latter to embrace the catheter: this pressure will be graduated spontaneously by the tolerance of the parts concerned. The instruments should be exchanged for larger ones every two or three days for a period rarely longer than a fortnight, always observing the rule already laid down, that *the catheter shall pass the stricture without any resistance*. During the treatment by this plan the instrument must be closed with a cork, which can be removed at stated intervals to allow the escape of urine.

After the urethra has in this way been considerably enlarged, the remaining part of the treatment may be carried on by periodical dilatation with steel instruments.

Divulsion.—A word derived from the Latin *divello*, "I tear or pull asunder,"

FIG. 1285.



The Wakely instruments for dilating strictures by the passage of graduated tubes.

has been employed to designate an operation which consists in rupturing or lacerating the tissues involved in a stricture and restoring the urethra to its proper size. The operation cannot be considered a recent one, but was practiced as early as 1835 by Perrève, a French surgeon, and at a later period by Professor Gross and other American surgeons. The original dilator or divulsor (for it was used for both purposes) designed by Perrève consisted of two thin blades united only at one—the vesical—extremity, and several rods of different sizes which were used for wedging the blades apart after the latter were passed through the stricture. An important improvement was afterwards made by this surgeon on his first instrument, by having a filiform gum bougie connected to its extremity as a guide in very close strictures. In England, where the operation is called splitting or rupture, divulsion was introduced chiefly through the influence of Mr. Holt, of the Westminster Hospital, who designed a modification of the Perrève instrument. (Fig. 1286.) Richardson's divulsor, a modification of Holt's, consists of

FIG. 1286.



Holt's divulsor.

plungers and of two slightly concave blades inseparably joined and olive-shaped at the vesical extremity, the other ends being fitted into a handle supplied with a screw designed to regulate the separation of the blades. Various other modifications of the original mechanism have been made from time to time, though in no way affecting the principle of operation. Among these may be mentioned the instruments of Voillemier and Thompson. It is a matter of little importance what instrument is used, so that the coarctated tissues are torn; though that of Thompson has certain advantages over others. The value of this instrument has been materially increased by the alterations which it has undergone in America, namely, by rounding the first two inches of the blades to prevent the mucous membrane from being punctured, and by having its extremity tunneled for the passage of a guide in cases of close strictures. The best of these modifications is that of Billings (Fig. 1287), in whose instrument the last three-quarters of an inch is a hollow tube, which materially lessens the chances of

FIG. 1287.



Billings's divulsor.

pinching or lacerating the mucous membrane, as in the case of divulsors in which the blades at this point are separable.

The manner of effecting the laceration by Holt's instrument is to introduce the divulsor through the stricture with the blades closed, when the latter are released by reversing the turns of the screw. The plunger is then introduced between the blades and driven home with a forcible impulse of the hand. Sometimes the plunger is passed down over a hollow guiding-rod added to the divulsor for the introduction either of a stylet or of a filiform guide.

In the use of Thompson's dilator, which can also be made a divulsor, the instrument is passed through the stricture, when the blades are rapidly separated chiefly at the seat of constriction by turning the handle until the object is believed to have been obtained. The mechanical power employed is not the same in the two instruments described. In that of Holt and in all others constituted on the same principle the divulsion is effected by the wedge; in that of Thompson, by direct expansion. In both, however, the mucous membrane can be torn in a *longitudinal* direction, and the tissues beneath more irregularly. The gap which is thus produced in the canal must be closed by granulation and cicatrization.

After the removal of the instrument there will be a discharge of blood from the urethra, provided the laceration has occurred,—a fact which will be further assured by the readiness with which a large-sized bougie, No. 18 or 20, can be passed. If the operation has failed in this respect, it will be either in consequence of the blades of the divulsor not having been sufficiently separated, or from some quality inherent in the stricture, as that of unusual elasticity. After the laceration has been completed and the instrument removed, a large-sized catheter should be passed into the bladder and the urine withdrawn. No instrument is to be retained in the urethra, though the same catheter is to be inserted every other day for a period of two weeks or more. Quinine and opium are also to be administered during the first twenty-four hours, with a view to prevent urethral fever.

The operation of divulsion is thought by some surgeons to be peculiarly well adapted to the treatment of irritable, resilient, or elastic stricture.

It is a rough, violent surgical procedure, and by no means free from danger. Encouraged by the representations of its advocates, I was induced to adopt the method in what I supposed were well-selected cases, but soon had cause to regret the practice, by having a fatal case occur in my hands. There are two facts which, in my judgment, militate against divulsion. *First*, nothing is accomplished which cannot be obtained by gradual dilatation. It is true the latter is a slow process; but I can conceive of no reason connected with a mere consideration of time which justifies a surgeon in jeopardizing the life of his patient. *Secondly*, the tendency to the reformation of the stricture is not lessened by divulsion. After laceration of the tissues an ulcer is left, and this can be repaired only by granulation and cicatrization. The new tissue will never become like the normal urethra, but will tend to contract, and will certainly demand the repeated use of bougies for an indefinite period. The most cautious advocates of the divulsive plan are disposed to limit its application to strictures located in the penile part of the urethra.

Rapid dilatation is a plan which professes to accomplish in a few moments that which by gradual dilatation would require many days. It occupies, therefore, a middle ground between the latter process and that of divulsion. It is no doubt true that in rapid dilatation the mucous membrane and the submucous tissues are often unwittingly torn; but this is not the object of the operator.

The plan is an old one. As early as 1812, Mr. Luxmoor, an English surgeon, employed for this purpose an instrument having four blades, which may be considered as having suggested a number of other similar appliances,—some with two and others with three blades,—devised by Mr. Weiss, a surgical cutler of London. The same end was effected at a later period by a succession of graduated tubes, one capable of being slid down over another. Chronologically considered, the most important of this class were the instruments of Desault, Buchanan, Hutton, Maisonneuve, and Wakely, the first

dating back as early as 1797 or 1798, and the last to 1850. Those of Wakely are the most perfect of the kind. A small catheter is first introduced into the bladder, and a metal guide secured to its end. Over this are passed in succession tubes of different sizes, which rapidly dilate the stricture. The most complete rod dilators are those of Thompson (Fig. 1288), and of Rigaud (Fig. 1289) and Michelenas, Mathews and Thompson.

FIG. 1288.



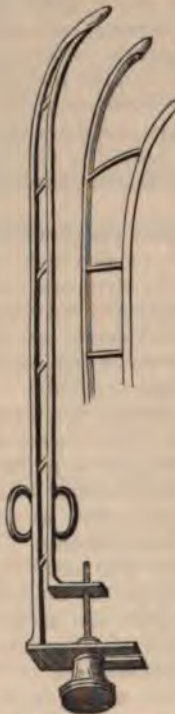
Thompson's dilator.

The last is to be preferred, as the dilating part of the instrument is limited to a small portion of the blades.

I do not believe that any advantage is gained by this mode of treatment. If the capacity of the canal is to be approximately restored by the removal, through a retrograde metamorphosis, of the new formation constituting a stricture (and doubtless this enters largely into the process), reasoning from analogy, it is much more likely to be effected by gradual than by instantaneous force.

Besides the plans enumerated, dilatation has also been attempted by rods of laminaria and by hydrostatic pressure as employed by Du Camp, by Arnott, and by Steurer.

FIG. 1289.



Rigaud's dilator.

Internal Urethrotomy, or Incision.—Urethrotomy is doubtless a very ancient operation, practiced in the beginning of the Christian era. The contrivances, however, which were employed in early times were exceedingly rude and imperfect, consisting of tubes through which were passed rods and stylets variously fashioned in order to scarify, puncture, or drill the obstructions. The earliest practical advance in the instrumental part of this mode of treatment is due to Physick, who, in 1795, designed a catheter bearing a concealed lancet which could be projected at pleasure. For the construction of the sheaths and knives which are now in general use we are indebted to Civiale in France, to Jamieson in America, in 1827, and to Stafford in England. The instruments of the last two surgeons were published at the same time, but were doubtless originated entirely independent of each other.

A great variety of urethrotomes have been constructed, among which may be named those of Civiale, A. Reybert, Maisonneuve, Gibson, Sédillot, Wood, Trélet, Thompson, Teevan, Pancoast, Otis, Mastin, and Gross. Some of these urethrotomes divide the stricture from before backward, and others from

behind forward: the latter are the safer instruments and should be preferred.

Those of Mastin, of Otis, and of Gross (Fig. 1290) embody everything necessary to the successful execution of the operation. The instrument of Gross, like that of Civiale, has a bulbous extremity, which enables the operator to locate with accuracy the precise limits of the coarctation.

Preliminary to the operation of urethrotomy it is necessary to dilate the stricture by a bougie to an extent sufficient for the admission of the instrument.

OPERATION.—The patient being under the influence of ether, a bougie (No. 7 or 8, French scale) is passed through the constriction; on its withdrawal the

urethrotome is introduced and pressed through the stricture, the passage of which can readily be determined by the freedom with which the bulb is felt to move in the canal beyond. Satisfied on this point, the operator now commences his incision a short distance on the vesical side of the coarctation, by pressing out the blade, directing it against the lower wall of the urethra, and then steadily withdrawing the instrument, the resistance to which will be felt increasing as the dense tissue of the stricture is encountered, and again lessening as the knife leaves its anterior face. The blade, however, should not be allowed to recede into the bulb until after the obstruction has been passed a short distance. The incision, if made properly, should extend at least from a quarter to half an inch on both sides of the stricture, and is much more likely to be too little than too free. A few drops of blood follow the withdrawal of the urethrotome, when a large-sized metallic catheter must be immediately passed. Should this be embraced to a degree which prevents the instrument from being easily slid up and down in the canal, there is some part of the stricture remaining undivided, and the urethrotome should be reintroduced, the incision repeated, and the catheter again inserted, to ascertain the completeness of the division. If this proves satisfactory, the metallic catheter should be replaced by a soft one, to be retained, a two-grain suppository of opium should be introduced into the rectum, and the patient remanded to bed. By retaining the catheter the wound is protected against the irritating effects of the urine, and, consequently, there is less liability to constitutional disturbance. The instrument, however, should not be allowed to remain longer than two days, when it must be removed. After this it will be necessary to pass every three or four days a metal bougie (No. 25 or 26, French scale), taking care to keep the point in gentle contact with the anterior wall of the urethra as the instrument is carried down, so as to avoid the wound in the canal. After two weeks the use of the bougie will not be required oftener than once a week, and finally once in two or three weeks. Professor Otis has combined in a most ingenious manner in the same instrument a urethrotome and a dilator. (Fig. 1291.) With this mechanism the stricture is divided along the upper wall of the canal and from before backward, and then without withdrawing the instrument the blades of the dilator are separated to an extent corresponding to the normal calibre of the urethra. The amount of separation is indicated by the dial-plate of the instrument.

The instrument of Dr. Mastin also embodies the dilator, urethrotome, and

FIG. 1290.



Gross's urethrotome.

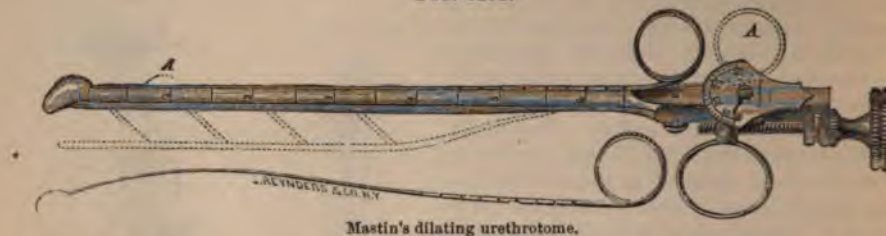
FIG. 1291.



Otis's dilating urethrotome.

dial-plate in one. The form of its extremity, that in which the knife is concealed, is particularly well adapted to communicate to the hand a precise knowledge of the extent of the coarctation, and, consequently, to render the incision exact. (Fig. 1292.)

FIG. 1292.



In all cases of resilient or irritable stricture, when little progress is made by dilatation, internal urethrotomy, especially in any part of the penile urethra, is a most valuable resource, infinitely superior to and safer than either forced dilatation or divulsion. In selecting a urethrotome, I do not think it a matter of much practical importance which of those described is employed.

The incision is a clean cut, and not a violent, rough laceration and mutilation of the diseased tissues, such as is inflicted by the divulsors. It is, consequently, followed by much less inflammation and infiltration than the operation done by the latter instruments.

Dr. Mastin has performed internal urethrotomy three hundred and twenty times without a single death. No better commentary on the safety of the operation than this can be asked. But, however valuable may be incision, it must not be deemed a radical cure for stricture, notwithstanding what is said to the contrary by sanguine urethrotomists. The *splice*, of which so much is said, and which occupies the gap between the sides of the divided parts, is granulation tissue; and the resulting cicatrix will always retain that invincible property of contraction. The tendency to coarctation in the canal is, it is true, lessened, but it is not destroyed; and hence the patient must be instructed to pass a metal sound once or twice every month if he expects to keep out of the hands of the surgeon at some future time.

CAUSTICS.—The treatment of stricture by caustics was practiced at different times for several hundred years, and indeed was employed within the present century. The agents used were sulphate of copper, caustic potassa, nitrate of silver, and other corrosive agents. These remedies, as applied to stricture, have deservedly fallen into disuse.

In summing up, then, the local treatment of urethral stricture, I believe that it is embraced under two heads: *first*, and *always first*, dilatation; and, *secondly*, failing in this, incision or internal urethrotomy, followed by dilatation.

External Urethrotomy.—It is barely possible that the tissues around a stricture of the urethra may be so altered as to render the passage of an instrument impossible and require an extended incision in order to open an unobstructed route to the bladder. These operations at one time were very common, and were sometimes performed in cases where the urethra was permeable. On the permeability or non-permeability of the stricture are based the operations distinguished as external urethrotomy performed with a guide and external urethrotomy performed without a guide, the latter procedure being known as *perineal section*, or one form of the *bouttonnière*.

External urethrotomy on a guide.—This operation was advocated by Mr. Syme in 1844. In its performance the patient, being etherized, is placed in the lithotomy position, and the hair shaved from the perineum. A Syme staff (Fig. 1293) is next passed through the stricture as far as to the shoulder

of the instrument, which is then committed to an assistant, who is directed to hold it steadily against the obstruction. The operator, sitting in front of the patient, makes an incision in the middle of the perineum dividing the tissues, with the back of the knife always towards the anus, until the staff can be felt with the finger, at the same time taking care not to open the deep perineal fascia. Entering the knife at the commencement of the groove in the large part of the instrument, and carrying it from before backward, he divides the stricture, together with a portion of the normal urethra, some distance in front and behind. If the operator has been careful not to deviate from the median line, very little blood will be lost. To avoid the possibility of perforating the urethra or entering into some false passage (a mistake which might easily be committed with an instrument having so delicate and rigid an extremity as that of Syme), Gouley uses a catheter staff which is grooved, except at its end, which is tunneled, and through which can be passed a filiform whalebone guide. (Fig. 1294.)

FIG. 1294.



Gouley's catheter staff.

After the free division of the stricture, the staff can be carried forward through the divided parts, or it can be withdrawn and a catheter passed along the urethra into the bladder, where it may be allowed to remain for twenty-four hours. The passage of the catheter will be facilitated by adopting the plan of Thompson,—that of first introducing into the urethra, through the wound, in the direction of the bladder, a director with a capacious groove.

After the removal of the catheter it will only be necessary to introduce daily a large-sized metallic sound until the external wound has almost healed, when by drawing the urine at proper intervals with a catheter the perineal opening will soon close. The operation is attended with a very low death-rate, only 7 deaths having occurred in 219 cases collected by Thompson.

External perineal urethrotomy without a guide is an operation demanding the most consummate patience and tact. It was performed as early as 1662 by Molins, an English surgeon. The patient is placed in the lithotomy position, and a grooved staff carried along the urethra until it encounters the stricture, against which it is to be held, while the surgeon, keeping in the middle line, divides the superincumbent tissues and opens the urethra on the staff in front of the obstruction. The edges of the wound are now to be drawn asunder by threads inserted through each, and, with a good light directed into the opening, the dense tissues of the stricture are to be carefully explored with a probe or a filiform guide of whalebone in search of the urethra. If discovered, a grooved director can be passed and the stricture divided. If, after a diligent examination, no opening can be detected, it will be necessary

FIG. 1293.



Syme's staff.

to lay open by installments the indurated tissue which composes the stricture, at each step renewing the attempt to detect the canal. Failing in this, and having incised the thickened structures, the search should be continued on to the vesical side of the stricture until the urethra is discovered, when the staff can be carried forward into the bladder or can be withdrawn and replaced with a catheter.

This operation has passed under the names of perineal section, *bouttonnière*, perineal urethrotomy, and more recently external urethrotomy. It is a very ancient procedure, having been executed for a variety of purposes, particularly for the extraction of foreign bodies from the urethra. It was advised in the latter part of the first century by Aretæus for the removal of calculi which became impacted in the urethra. As an operation for the relief of retention it was noticed both by Rhazes and by Avicenna, the former belonging to the tenth and the latter to the eleventh century. Its reduction to a system, however, does not appear until 1525, when, as a preliminary measure to a method of lithotomy known as the *major apparatus*, perineal urethrotomy was popularized by a surgeon of Cremona, Giovanni, and his follower, Mardanosanto. The first instance which can be regarded as authentic of perineal urethrotomy performed for stricture is that recorded by Richard Wiseman, in 1652. This operation was followed by those of Solingen, and about 1690 by those of Tolet and Colot. La Faye mentions the operation and the manner of executing it in 1765; and in 1730 Le Dran gives an account of having treated an impassable stricture by this method. In 1783 the perineal section was done by John Hunter at St. George's Hospital, London, after which we hear little about the operation until 1815, when it was again agitated by Mr. Granger, of Birmingham, followed by Mr. Arnot and Mr. Guthrie. Professor Gouley, to whom we are indebted for an excellent *résumé* of the literature of this subject, has given a chronological notice of the operations in America, which were first advocated and performed by Alexander H. Stevens, of New York, in 1817; in 1820 and 1823 by Dr. Jamieson, of Baltimore, who operated ten times successfully; by Dr. David L. Rogers, in 1823, and who reported twelve cases; by Dr. J. C. Warren, of Boston, and others by Drs. Hoffman, Post, Watson, and Buck.

The popularity of the operation will appear from the fact that the books of the New York Hospital record seventy-five cases. To Mr. Syme and to Drs. Van Buren and Gouley we are indebted for the improvement in the instruments employed in the operation.

The success of this operation will depend on the sound condition of the internal organs, especially the kidneys, on the character of the perineum, which is less favorable in obese subjects, where the urethra lies very deep, and on the skill with which the task is executed. Success depends much, very much, on confining the incisions to the middle line and avoiding all lateral dissections. In 345 cases of external urethrotomy performed by American surgeons and collected by Gouley, 233 of which were performed without a guide, there were 40 deaths, a mortality of 12 per cent. A different result is exhibited in the 35 cases collected from the practice of German and French surgeons by Boeckel, 8 of whom died, or a mortality of 28.85 per cent.

Subcutaneous urethrotomy.—This operation, suggested by Dick, consists in introducing obliquely through the tissues a narrow-bladed bistoury resembling a tenotome, and dividing the stricture on a grooved staff previously passed into the urethra. Dr. Mastin, of Alabama, and Mr. Teevan, of London, have each performed an operation of a similar nature.

Diseases of the Prostate Body.

The prostate is a musculo-glandular body, the muscular element predominating very much over the glandular. It is very small in children. Its size is notably increased about the period of puberty, in accordance with the

changes which occur at that time in the sexual organs, with which it is intimately associated in functions. The contraction of its muscular component projects the semen from the prostatic sinus during the culmination of the venereal orgasm. It therefore sustains a peculiar sympathetic relation with the nerves of this part of the urethra. The position of the prostate with regard to the bladder, the urethra, the ejaculatory ducts, and the rectum, and its intimate relations to all four, impart additional importance to its diseases.

INFLAMMATION OF THE PROSTATE.—Inflammation of the prostate body is rarely met with as a primary affection, being in most instances secondary to urethritis, cystitis, and stricture, or being due to traumatic causes, such as the injudicious use of sounds, bougies, strong cauterizations, impaction of a stone, and lacerations in the extraction of urinary calculi. The inflammation may be acute or chronic.

Acute inflammation.—The earliest sign of acute prostatitis is a feeling of weight and fullness in the perineum and rectum, with more or less uneasiness about the neck of the bladder, accompanied by a frequent desire to pass water, pain being experienced at the termination of the act. These symptoms, which at first are not very marked, become more and more urgent as the inflammation increases; the desire to urinate is constant and irresistible; the pain, at first dull and intermittent, grows in severity, is throbbing, darting, and continuous, and is no longer confined to the perineum, but radiates to the back, down the thighs, to the anus, testicles, and along the spermatic cords and the urethra. Indeed, it travels in all those directions in which there are nervous cords communicating with the hypogastric plexus. The suffering is greatly aggravated by micturition and defecation. Even walking or sitting augments the distress. The difficulty experienced in passing water increases with the inflammatory swelling of the gland until it may amount to complete retention.

The local symptoms are usually attended with general disturbance of the system, marked by rigors, increased heat of surface, an elevated temperature, a full and frequent pulse, thirst, loss of appetite, and a loaded tongue. When the rigors are repeated and the throbbing of the perineum continues, supuration may be anticipated, and if the urine is carefully examined it will usually be found to contain pus.

DIAGNOSIS.—Acute prostatitis may be confounded with cystitis and urinary calculus; but the distinction may be established by attending to the following considerations:

PROSTATITIS.

Not a common disease.
Pain chiefly restricted to perineum and anus and accompanied by fullness.
Pain is violent and throbbing.
Stream of urine diminished in size.
Pain aggravated during defecation.
Retention of urine probable.
Digital examination of the rectum reveals marked swelling and tenderness of the prostate.

CYSTITIS.

A common disease.
Not so limited, and little, if any, perineal or rectal fullness.
Is not.
Stream of urine may be normal in size.
Not necessarily so.
Impossible.
No enlargement, and little tenderness.

Stone in the bladder is readily distinguished from prostatitis by the pain being always referred to the meatus and felt at the end of urination; by the absence of constitutional disturbance; by the gradual development of the vesical symptoms; and especially by the rough sensations communicated to the hand through the medium of the sound.

The pathological changes which characterize acute prostatitis are vascular engorgement, transudation, and infiltration of the connective tissue of the body with inflammatory products, as lymph, blood, and pus. The latter, when present, are not usually confined to an isolated portion of the gland, but disseminated generally through its substance, which is sometimes appreciably soft and friable.

Acute prostatitis runs its course in seven or eight days, terminating in resolution, chronic inflammation, or suppuration.

TREATMENT.—Acute prostatitis is a disease which demands prompt and active treatment. In a strong, vigorous patient general blood-letting may be employed; but usually the same object is attained, and even more quickly, by the free application of leeches to the perineum. Afterwards an active saline purge should be administered, followed by enemata, and by large hot poultices over the perineum, frequently repeated. As a substitute for the latter, hot hip-baths may be employed, or the vapor of hot water may be used, by slipping a piece of rubber hose over the spout of a tea-kettle and carrying its free end beneath the clothing to the perineum, against which the steam is allowed to escape.

Should the swelling of the prostate cause obstinate retention of the urine, the catheter, though it gives rise to pain, must be used three times in the twenty-four hours to relieve the bladder, as the continued presence of the urine will serve to aggravate the local distress. The urine must be kept bland and diluted by the free use of flaxseed or slippery-elm tea; and when the patient is in bed the hips should be elevated, in order to take off the tension of the blood-vessels of the pelvis. For some time after the acute symptoms have vanished there will remain considerable swelling of the gland from the presence of the infiltration, which, by encroaching on the urethra, will materially lessen the size of the stream of urine and cause some difficulty in its free expulsion. This, like all inflammatory depositions, requires time for its removal, which can only be effected by the venous and lymphatic vessels. At this stage of the disease, and when all the urgent symptoms have disappeared, both patient and physician are sometimes betrayed into a false security, supposing that the cure is accomplished and little further attention required. No greater mistake can be committed. If the patient is allowed to rise from his bed and to go about, if he ventures to indulge in wine, or to give the reins to his sexual inclinations, a passive congestion of the gland will, in all probability, ensue, on which is laid the foundation of a permanent hypertrophy. Hence at this stage of the disease we should insist on continued rest in the recumbent position, on keeping the bowels in a soluble condition, and on giving from time to time an alkaline diluent, to render the urine as bland as possible, and the iodide of potassium for the benefit of its resolving power over plastic deposits.

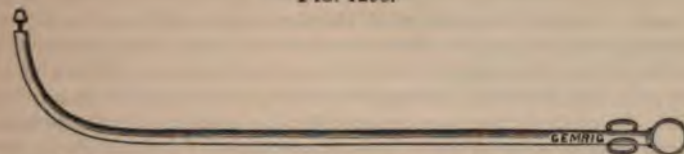
Chronic Prostatitis is a sequel of the acute disease, rarely appearing as a primary affection. There is some enlargement of the prostate, a slight tenderness when the gland is pressed upon with the finger, a discharge of glairy mucus, a feeling of weight in the perineum or at the end of the bowel, and an ache or pain experienced during the sexual orgasm and in passing the urine, which cannot be projected with any force from the urethra, and, in addition to being cloudy, deposits on standing a muco-purulent sediment.

TREATMENT.—A patient who labors under chronic inflammation of the prostate following an acute attack ought not to be allowed for some time to remain on his feet. He should assume a recumbent position, though not necessarily in bed. A few leeches at intervals of every four or five days should be applied to the perineum, and these may be followed by a small blister or by two or three threads introduced as a seton. Quinine, iron, and strychnine will be required to restore the general strength, which has necessarily suffered from the preceding acute attack. Ergot will be found very useful in these cases, by inducing a tonic contraction of the muscular constituent of the prostate, thus favoring the absorption of the plastic infiltration which permeates its structures; its efficacy will be increased by administering the remedy with the iodide of potassium (ext. ergot. fld., gr. xv; potass. iodid., gr. vi; aquæ, ʒii) three times a day.

When the patient is harassed with nocturnal emissions, the sensibility of the prostatic sinus should be diminished by applying to this part of the

urethra, with the proper instrument (Fig. 1295), a solution of nitrate of silver (nitrate of silver, grs. xv; distilled water, ʒi).

FIG. 1295.



Catheter for applying nitrate of silver to the prostatic sinuses, having at one end of stylet a wrapping of cotton.

Prostatic Abscess is one of the sequels of acute prostatitis, though I have met with it when all the symptoms pointed to a slow chronic inflammation. It may be solitary or multiple, confined to one lobe or scattered through the different lobes of the prostate body. The existence of abscess in the prostate may be suspected when the pain, difficulty of urination, throbbing, and fullness in the perineum and rectum continue beyond the usual period of duration of the disease, and particularly when, superadded to these symptoms, there occur rigors, flushes of heat, feverishness, and sweating. Our suspicions will receive decisive confirmation if, on introducing the finger into the rectum, a soft, fluctuating swelling is discovered in the gland.

Abscesses of the prostate discharge their contents sometimes into the bladder, at other times into the urethra or the rectum. If the prostatic fascia becomes thickened and detached from the gland, the pus may travel up between the bladder and the rectum and finally open into the pelvis. Occasionally the abscess has taken the opposite direction and pointed slowly in the perineum, following the course of the middle perineal fascia.

When the opening occurs into the rectum or into the urethra, it is announced by the sudden appearance of thick, laudable pus in the alvine evacuations or in the urine. Whether the abscess discharges into the bladder or into the urethra, the pus will escape through the latter channel. But there should be no difficulty in determining the original seat of the opening, inasmuch as the discharge of matter would occur only during urination, when the bladder had received the contents of the purulent accumulation, while if the communication has taken place between the prostate and the urethra the escape of pus will be quite independent of micturition.

In any event, abscess of the prostate body is an unfortunate termination, as the urethral, vesical, or rectal openings are prone to remain as fistulae. The cavities which in multiple abscess exist in the gland often fail to contract, and continue to furnish from their walls a sufficient amount of pus to maintain a constant discharge. This may continue until the entire gland is disorganized.

TREATMENT.—An early recognition of the abscess has an important bearing on the success of the treatment. If it can be detected and opened before the structure of the prostate has been extensively disturbed, the prospect of a permanent fistula will be lessened, as also will be that of pelvic complications from an extension of disease along the cellular tissue in the recto-vesical space.

As soon, therefore, as these physical signs of bulging and fluctuation appear, the swelling should be opened. If the abscess points towards the rectum, it should be punctured either with a long, sharp-pointed bistoury, slightly curved at its extremity, and conducted along the finger, or in the depression between two fingers introduced into the rectum, with their tops resting against the prominent portion of the gland; or by means of a trocar and cannula, the point being concealed in the latter until the prostate is reached, as practiced in tapping the bladder through the bowel. A third plan for incising the abscess, and one which has the advantage of exposing the entire procedure to the eye, is first to introduce a cylindrical rectal speculum having

a large fenestra, and, after adjusting the instrument so that the swelling will protrude through the opening in its side, a puncture can be made into the abscess with a bistoury. When the bulging appears in the perineum, the pus should be liberated by pushing a sharp-pointed bistoury with a long narrow blade through the tissues of the perineum, with its back to the rectum, entering it on the raphé about one inch in front of the anus, and with a finger in the bowel directing it safely to its destination. When the abscess points towards the urethra, its diagnosis must necessarily be to a great extent inferential. An obstruction encountered by the catheter in the prostatic part of the canal would, with other concomitant signs of suppuration, be a sufficient justification for operative interference. When mature, even the contact of the end of the catheter has been sufficient to rupture the thin stratum of tissue which confines the pus and to allow its escape through the urethra. This should always be tried before employing any other measure. If it fails, the puncture can be made by a canula catheter armed with a trocar-pointed stylet.

It is desirable, after the evacuation of an abscess, in order to prevent the urine, air, or feces from entering the opening leading to the abscess and exciting inflammation and keeping up the suppuration indefinitely, to leave a soft catheter in the bladder for three or four days at a time, when the opening has occurred into the bladder. But when the pus has passed directly into the urethra or into the rectum, and the continence of the bladder remains unimpaired, the periodical use of the instrument will be sufficient.

It is this difficulty with the urine that has suggested the propriety of emptying the abscess and at the same time furnishing a new route for the water until the suppurating cavity contracts, granulates, and closes. This is done by laying open the perineum, guided by a staff in the bladder, as is done in the median or the lateral operation for stone, only observing not to prolong the incision into the neck of the bladder, but simply through the prostate body. When the signs all point to a spontaneous opening into the bowel, it will be better to discharge the abscess by the rectum. The most opportune time for this procedure will be before the abscess has broken, and when it points in the rectum, under which circumstances the benefits likely to accrue will more than counterbalance the risks of the operation.

ABSCESS EXTERNAL TO THE PROSTATE.—In consequence of severe contusions, or from a false passage made in inserting a catheter, inflammation is liable to be kindled in the loose cellular tissue which connects the prostate and bladder with the rectum. The symptoms counterfeit with considerable accuracy those of prostatic abscess; that is, there may be retention of urine, with swelling and fluctuation in the rectum or perineum, and similar constitutional disturbance. In the former, however, the swelling is diffused and not definitely circumscribed, as in prostatic abscess, and in almost all instances points in the posterior or anal perineum, and distends the ischio-rectal spaces, as its origin is behind the middle perineal fascia.

Early and free incisions must be made, not waiting for the pus to reach the surface. Any timidity or hesitation about doing this will allow extensive sloughing of the cellular tissue of the perineum, produce rectal fistula, and perhaps cost the patient his life.

Prostatorrhœa.—This affection, first described by Professor Gross, is not a very common disease, but is the source of much anxiety to young men. It is characterized by the discharge of a consistent or ropy mucus of a grayish-white color, which is passed after urination and during those spasmodic contractions of the prostate which are concerned in expelling from the urethra the last drops of urine. Or it may occur either from the pressure of the feces against the prostate body, or from the straining effort necessary to expel the contents of the rectum. The quantity which is passed at these times varies from ten or twelve drops to almost a teaspoonful. The clear, transparent mucus which sometimes oozes slowly from the urethra, keeping

the external orifice of the canal constantly moist, and which is referred to the prostate gland as its source, is a characteristic of folliculitis rather than of prostaticorrhœa. The effect of this discharge is peculiarly depressing to the mind of the patient, who imagines, to use his own expression, that he is losing his semen, and that it will be followed by a total loss of sexual power. It is not at all uncommon to meet with cases of this nature in which the mind of the patient has become so thoroughly occupied with imaginary anticipations of evil that he has been rendered alike incapable of attending to business or enjoying the pleasures of society.

DIAGNOSIS.—The only affections with which prostaticorrhœa can be confounded are gleet, spermatorrhœa, and cystitis. In gleet the discharge is either muco-purulent or purulent, while in prostaticorrhœa it is grayish white and free from admixture with pus. In the former disease, moreover, there is always a history of a previous gonorrhœa, which is not a necessary antecedent to prostaticorrhœa. The most decisive differential test between the latter affection and spermatorrhœa is that furnished by a microscopic examination of the fluid, which in the latter contains a large number of spermatozoa, while in prostaticorrhœa very few can be detected. In cystitis, urine which is passed at first cloudy, on standing for a short time deposits a heavy muco-purulent sediment; there are also frequent micturition, and more or less pain, none of which symptoms belong to prostaticorrhœa.

CAUSES.—The causes of prostaticorrhœa are almost invariably masturbation or sexual excess. It is more particularly a disease of young unmarried men. The symptoms attending the affection scarcely warrant the assumption of there being any inflammatory element present, but rather point to a super-sensitive state of the excito-secretory nerves of the prostate body, favoring passive congestion of its vessels.

PROGNOSIS.—Though free from all danger to life, prostaticorrhœa is an obstinate affection, requiring often months, or even years, for its cure.

TREATMENT.—Much will have been accomplished towards a cure if the mind of the patient can only be dispossessed of the evil spirit of despondency which clings to him with such relentless pertinacity, and it is our first duty to exorcise this demon by assuring him of the perfectly harmless nature of the malady; or, if this will not answer, by changing the mode of assault and shaming him for his pusillanimity and want of manliness. The mind should next be interested in pure and entertaining books if the patient is a man of leisure, and all conversation, company, and amusements which are calculated to excite or foster sensual thoughts must be avoided.

Nothing can be more unfortunate than for a patient suffering from prostaticorrhœa to have no employment. The remedies to be administered are those calculated to improve and invigorate the general health, among the most valuable of which are iron, quinine, strychnia, and cod-liver oil. All fecal accumulation must be avoided; and hence the necessity of keeping the bowels regular.

At night, if the patient suffers from lascivious dreams or nocturnal emissions, a dose of bromide of potassium and a pill of extract of belladonna may be given. Not the least important element in the management of this affection is the use of cold baths; the hip-bath is to be preferred, and this should be used every evening, the patient sitting for twenty minutes in the water before going to bed. The soft parts over the sacrum, hips, and perineum should be well flagellated with a muscle-beater for ten minutes. All highly-seasoned or stimulating food, all alcoholic drinks, smoking, and sexual indulgence, must be scrupulously avoided.

Hypertrophy of the Prostate Body.

Hypertrophy of the prostate is an enlargement referable to an excessive nutrition of its anatomical components, altogether independent of inflammatory changes. This change is essentially a senile one, being rarely seen under

fifty years of age, and the more remarkable from the fact that at this time of life, when the forces of growth have culminated in all other parts, they should assume inordinate activity in the prostate. The enlargement may be centric or eccentric,—that is, the body may grow in size in the direction of the urethra and bladder or towards the rectum. The hypertrophy may affect a single lobe, but more frequently the entire body. Its bulk varies from the

size of a walnut to that of a goose-egg. I have seen the prostate over three inches in transverse diameter. As it increases, the shape of the gland is changed, its antero-posterior diameter is increased, and its body, when the hypertrophy is general, assumes a globular appearance. (Fig. 1296.) The effect of such an enlargement is to elongate the prostatic portion of the urethra, as well as to alter its form and lessen its capacity.

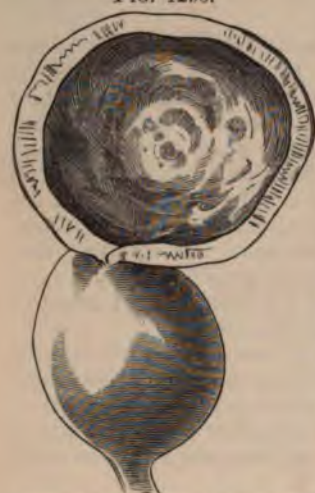
When the hypertrophy is chiefly limited to one of the lateral lobes, the direction of the urethra will deviate from a straight course, assuming an angular position with reference to the bladder, towards the right or towards the left of the median line, according to the lobe affected. When the middle lobe is the subject of the hypertrophy, it usually projects upward into the mouth of the bladder, and as it increases in magnitude becomes somewhat pedunculated, imparting an angular curve to the urethra, the vertex being upward.

Various other outgrowths of the prostate are occasionally witnessed, in which two or more mamillary masses, often somewhat pedunculated, may rise from the floor of the neck or from one of the lateral lobes and project into the mouth of the bladder.

Frequency.—While hypertrophy of the prostate is often met with among aged persons, there is no doubt that its frequency has been greatly over-estimated. In 312 examinations made by Dr. John W. Lodge, 246 were found to be normal, 5 atrophied, and 61, or 19.5 per cent., hypertrophied. The persons examined varied in age from forty to one hundred, and, being inmates of the Philadelphia Almshouse, belonged to a class in whom this affection might naturally be expected. Sir Henry Thompson and Dr. Messer have prosecuted similar inquiries, the result of their labors showing about 32 per cent. of those examined to have had slight hypertrophy and 12 per cent. marked enlargement sufficient to cause more or less inconvenience. In 115 persons examined by Professor Dittell, 18 had hypertrophied prostates and in 36 the body was atrophied. I have myself made many similar examinations, and can confirm the infrequency of hypertrophy; but the percentage of atrophy, I think, is much over-estimated. The sense of touch is a very deceptive test in determining the fact of the gland being under size. I have a considerable number of bladders which were removed from old persons who died from various diseases, and in all of them the prostates before being cleaned from their adventitious connections would have been regarded as atrophied, but, after careful dissection, are shown to be entirely normal. The weight of the healthy prostate is about five drachms, its antero-posterior diameter averaging three-quarters of an inch, and its transverse and vertical diameters one inch.

PATHOLOGY.—The anatomical components of the prostate body are smooth muscular fibres, connective tissue, and glandular tissue. The hypertrophy is essentially an excessive development, chiefly of the muscular fibres and of the connective tissue, which normally constitute almost three-fourths of its

FIG. 1296.



General enlargement of the prostate body.—From a preparation in the Museum of the College of Physicians.

substance. The glandular tissue undergoes no increase,—in fact, is rather atrophied, and, in cases of uniform hypertrophy, it may be entirely destroyed, though in the nodular or irregular form of prostatic hypertrophy there is a real glandular hypertrophy, which includes, of course, a multiplication of the tubuli as well as increase of the epithelia. In addition to the general and the irregular enlargement of the prostate, it is quite common to find one or more small tumors projecting from its substance (Fig. 1297), and which may without difficulty be shelled out of their bed.

These growths, which vary in size from that of a pea to that of a pigeon-egg, and are very dense and elastic when laid open, are seen to consist, like the prostate itself, of muscular and fibrous tissue, with very little, however, of the glandular element. They are not peculiar to the hypertrophied prostate; they will often be found in a gland which is in all other respects sound.

This tendency to the development of musculo-fibrous growths in the substance of the prostate is so much like that which occurs in the uterus of the female about the period of the menopause, that the anatomical analogy between the two organs appears to be well sustained.

SYMPTOMS.—One of the earliest symptoms which betoken prostatic hypertrophy is increasing frequency of micturition, with a little detention in starting the stream. This may continue a long time without causing any particular inconvenience or even awakening the least suspicion of anything being wrong. As with increasing years there usually comes a growing desire to urinate with greater frequency, the urination is referred to what is believed to be the necessary attendant of senility. Along with this desire to micturate there is a noticeable diminution in the force with which the stream escapes from the urethra, and an increased effort is necessary to eject it, especially at the commencement of the act. As the disease advances, the calls to urinate become more urgent, the patient is compelled to rise repeatedly during the night, and his sleep is therefore broken and disturbed. There is a feeling of fullness, weight, and discomfort in the perineum and bowel, which often communicates the sensation of a half-completed alvine defecation. Pain when present is not uniform in its location, being sometimes felt in the glans penis, sometimes along the whole tract of the urethra, and at other times seated at the neck of the bladder. As the encroachment upon the urethra progresses, the trouble experienced in dislodging the urine increases. It is some time before it begins to pass, and then slowly and only after forcible and protracted muscular efforts, which barely answer to impel the stream sluggishly along its channel, when it falls at the feet instead of being projected in a curved jet from the meatus. The same difficulty that is realized in starting the urine is felt in completing the act. The final propulsive contractions, which normally are so efficient in ejecting the last drop and promptly clearing the canal of all moisture, are so impaired and imperfect that a portion of water remains in the urethra, gradually dribbling out, so that the clothes of the patient become wet and soiled.

With this growing muscular insufficiency, and the massive obstruction at the mouth of the bladder, a certain amount of water remains in the dependent part of the bladder. This, if not detected, gradually accumulates, only the

FIG. 1297.



Multiple tumors in the prostate and projecting into the mouth of the bladder.—From a specimen in the Museum of the College of Physicians.

overflow escaping, until the organ becomes increased in size; and finally, as the distention increases, the urine begins to dribble away, especially during sleep, when the volition of the patient no longer operates to control the neck of the bladder. It is this apparent incontinence, which often goes by the name of *vesical paralysis*, which is liable to deceive the practitioner, who, unable to reconcile a constant flow of urine with the idea of retention, fails to relieve the accumulation by the use of the catheter. In addition to these signs, the straining which is required to expel any part of the contents of the bladder often occasions a mucous discharge from the urethra, prolapse of the bowel, hemorrhoids, swollen testicle, and sometimes hernia. In some cases the stools are passed in a flattened form, owing to the action of the muscles of the bowel and the resistance of the hypertrophied prostate, which encroaches on the cavity of the rectum.

The urine in time undergoes important changes. The portion retained in the *bas-fond* of the organ decomposes, and this reacting on the vesical mucus soon excites cystitis; the secretion is not lessened in quantity, but is rather increased above the normal amount. When passed from the bladder it is thick, cloudy, usually strongly alkaline, but sometimes acid, and deposits on standing a ropy mucus mingled with phosphates, and possibly discolored with blood, which becomes exceedingly offensive from the sickening odor which it emits.

With the progress of the local trouble the health of the patient becomes deeply implicated; a slight exposure to cold or any irregularity in the ordinary habits of living is sufficient to aggravate all the local symptoms, by exciting an increased congestion of the prostate and bladder, accompanied with fever. And, to add to the severity of his sufferings, an attack of retention may occur at the same time. As is the ordinary history of chronic incurable maladies, the disease, with occasional respites, steadily advances. One acute attack follows another with increasing frequency, until, worn out by loss of rest and by severe, often agonizing suffering, the scene is closed from sheer exhaustion, ulceration of the bladder, or perhaps uræmic poisoning.

DIAGNOSIS.—Should any doubt remain with reference to the existence of prostatic hypertrophy after recognizing such a symptomatic portraiture as has been drawn, a digital examination will remove all obscurity or uncertainty in the matter. The prostate body is readily felt through the rectum, and its outline and magnitude can be accurately determined with the finger in the bowel, when passed in different directions over its surface. The examination should be made with the patient on his back, with the limbs drawn upward and separated, and may often be rendered more satisfactory if conducted with a catheter in the bladder. The physical examination through the rectum may, however, in centric hypertrophy of the prostate, fail to communicate the desired information, as the growth is inward and may cause no peripheral alteration of the body from its normal size. We must, then, when the rational signs of prostatic enlargement are present, proceed carefully to eliminate by exclusion the probability of stricture and stone, which most assimilate the disease. This can be done only by an instrumental exploration of the urethra and the bladder, and a careful inquiry into the history of the patient.

When an obstruction is encountered only at the neck of the bladder, requiring a sudden and abrupt change in the direction of the instrument to surmount it, and when the subject is between fifty and sixty years of age, and there are present no characteristic signs of stricture or urinary calculus, everything points to the existence of internal or centric hypertrophy of the prostate.

The evil effects of prostatic hypertrophy are experienced in different ways:

1st. The flow of urine is impeded, which is the most common and distressing result of the disease. This is in consequence of the obstructive mass planted at the mouth of the bladder, and also arises from the change in the direction and size of the urethra, which has already been described, and

which varies according as the median or the lateral lobes of the prostate are affected.

2d. The bladder, in consequence of the difficulty experienced in expelling its contents, invariably suffers in unrelieved cases of prostatic enlargement. The severe, frequent, and partially fruitless efforts made by the walls to dislodge the urine induce hypertrophic enlargement of the bladder and of its muscular coat, the fasciculi of which give to the interior of the organ a ridged or columnar appearance. The same influence which is at work to produce the thickening of the muscular fibres is influential in causing lateral pouches or sacs to form, by the protrusion of the less resisting parts of the bladder between the muscular ridges. A transverse ridge or bar sometimes forms across the surface of the trigonus vesicæ, which may also oppose a barrier to the escape of urine. It is caused by hypertrophy of the transverse muscular fibres which cross this part of the bladder. It owes its chief importance to the notice which it has received from Mr. Guthrie. It is not, however, always peculiar to hypertrophy of the prostate, but may occur entirely independent of this disease, and under any circumstances is an exceptional condition. In addition to this muscular bar, two others are occasionally seen in the neck of the bladder, both consisting of hypertrophied submucous tissue. One of these appears immediately over the middle lobe of the prostate, and the other, when present, between the middle and one of the hypertrophied lateral lobes of that body. In singular contrast with the enlargement of the bladder is another change, in which the organ becomes contracted and its cavity greatly diminished. This is likely to occur in cases in which, though the prostate may be very large, the hypertrophy does not involve the median lobe and is symmetrical in the lateral lobes, so that no obstruction rises between the urethra and the mouth of the bladder. The freedom with which the urine escapes in this condition does not admit of residual collections, and, consequently, there is little excess of mucus; and the intolerance of the bladder to the pressure of water tends both to diminish its capacity and to cause a centric hypertrophy of its muscular walls.

Cystitis is another of the sequels of enlargement of the prostate, and originates from the influence of decomposed residual urine on the mucous membrane, assisted by the constant congestion of the latter, produced by inordinate increase of function in the muscular walls of the bladder.

3d. The excessive supply of mucus which is excited by the action of the ammonia resulting from the decomposition of the urea may, in connection with phosphatic depositions of the urine, crystalline or amorphous, form little masses sufficiently consistent to serve as the nucleus for a stone. The conditions which are particularly favorable to such formations are found in the sacculated bladder. The pouches, from the manner in which they are formed, being deficient in muscular fibres, allow the little pools of water which they contain to remain and to deposit those materials which form the bases for calculi.

As in stricture and cystitis of long standing there is a tendency in the ureters and kidneys to become implicated, so in hypertrophy of the prostate these organs rarely escape unharmed: varicose dilatations of the ureter, with local hypertrophy of its muscular walls, and abscess, cysts, and other inflammatory changes of the kidneys, are the morbid alterations of structure likely to ensue.

TREATMENT.—Senile hypertrophy is an incurable malady, yet one which can be greatly palliated, and in which the patient can do a great deal towards his own comfort. He must make up his mind to pursue a rigid course of systematic living, from which under no circumstances should he be tempted to deviate; his food must be plain, consisting largely of vegetables and milk. Meat should be taken in moderation; all stimulants are to be eschewed, as well as every acid fruit, though lemonade is sometimes advantageous. Riding on horseback or in carriages over rough roads must be avoided, and when in the

house it is wise to recline rather than to sit erect. The body, bowels, and feet are to be preserved warm and dry with scrupulous care, the bowels to be maintained in a regular condition, and all sexual excess avoided. These preliminaries arranged, the next important step is to provide against the evil effects of the mechanical obstruction to the passage of the urine. Unfortunately, the prejudice which exists against the use of the catheter, even among medical men themselves, operates greatly to the disadvantage of the patient: he delays and suffers, and suffers and delays, as long as water can be passed at all, under the impression that the employment of an instrument is a last and extreme resort, when in truth it is our sheet-anchor, first and last. The moment, therefore, that it is discovered that a portion of water remains in the bladder which cannot be displaced by the voluntary efforts of the patient, that moment is the catheter indicated in order to prevent the ill effects resulting from the retention of residual urine.

The frequency with which the catheter should be used must depend on the completeness with which the bladder is emptied. It may be required once, twice, or even three times in the twenty-four hours.

A patient will often be able to empty the bladder by resting, during urination, on the elbows and feet when it cannot be completely done in the ordinary position. A like success is sometimes achieved by turning on one or other of the sides; and I have a patient who has been able to avoid the use of the instrument for a week at a time by placing one foot on his bath-tub and leaning over to the opposite side with the supporting limb semiflexed.

The tolerance of the urethra and bladder to instrumentation must also have its weight in regulating the number of catheterizations. If the passage becomes irritable under the operation, it will be better to make the intervals as long as possible consistent with the safety of the bladder. A prominent physician of Philadelphia told me that he had drawn his water regularly three times a day for seventeen years, and that, though engaged in an extensive practice during that time, he had enjoyed life as much as any of his medical friends.

The patient should be early taught how to pass the instrument himself. The soft catheter is always to be preferred when it can be passed into the bladder. That of Mercier (Fig. 1298) is admirably adapted for the purpose; or the ordinary gum catheter having a stylet with which to preserve the

FIG. 1298.

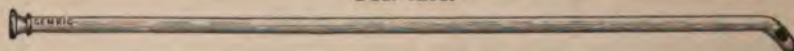


FIG. 1299.

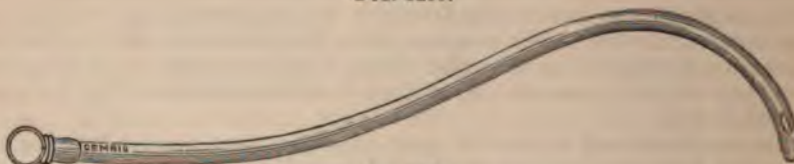


FIG. 1300.



Catheters, gum and metallic, suitable for use in cases of enlarged prostate.

short, abrupt bend at its vesical extremity, which is so often required to mount over the prostatic eminence at the neck of the bladder, may be used.

(Fig. 1299.) The same curve, approximately at least, will be demanded in the silver catheter when that instrument is employed. (Fig. 1300.)

Various remedies have been recommended for reducing the prostate. Among these are iodide of potassium, mercury, buchu, ergot, and iodine. The two last-named have been injected into the gland. Mechanical pressure, hydrostatic and by other means, through the rectum, has had its advocates, but is valueless.

When the obstruction is great, requiring the constant use of the catheter, one of two operations may be practiced, either *supra-pubic cystotomy** or *median perineal prostatotomy*,† with drainage until a fistula is established, and in each the removal of any part of the gland encroaching on the cavity of the bladder.

A patient laboring under enlarged prostate is liable, as a result of exposure to cold or dampness, or from some other indiscretion, to suffer from acute attacks in consequence of the resulting vascular engorgement of the gland, the swelling from which blocks up the urethra and the mouth of the bladder so as to produce complete retention, and this generally requires the assistance of the surgeon for its relief. A few leeches to the perineum and a hot hip-bath will materially assist in removing the swelling and opening the way again for the voluntary discharge of the urine. Much injury is done under these circumstances by persistent efforts at catheterization. It would be better to do a supra-pubic aspiration than to subject the urethra to traumatic violence and endanger the life of the patient.

PROSTATIC CALCULI.—Calculi are occasionally met with imbedded in the substance of the prostate body. They may exist singly or in great numbers, are quite hard, and vary in size from that of a grain of sand to that of a pea. Their color is not uniform, being sometimes white and at other times yellow or brown. They are occasionally so closely packed together that the cyst-like walls of separation become absorbed and the calculi rest together at their borders, having a pavement-like appearance, or constituting a figure like that presented by the back of a tortoise.

These bodies are most probably formed on a nucleus of inspissated mucus.

In the ducts and follicles of the prostate gland of the adult there exist in great numbers at all times minute bodies, the nature of which is not entirely understood. They are believed by Virchow to be composed entirely of organic matter. Occupying the position which they do, they probably consist of the inspissated secretion of the gland-tissue of the prostate, as occurs frequently in the biliary and salivary ducts as a precedent condition of biliary and salivary concretions. The addition of the carbonate and phosphate of lime to these bodies, by increasing their bulk, gives rise to local irritation and favors the further deposition of the inorganic salts of the prostatic secretion, until they become of sufficient magnitude to occasion great suffering.

Their composition, according to Wollaston, is phosphate of lime, carbonate of lime, and animal matter; 84 per cent. of the first, $\frac{1}{2}$ per cent. of the second, and 15 per cent. of the last. When small, they may not cause any great uneasiness, but when they attain sufficient size to encroach upon the urethra or mouth of the bladder they are capable of developing all the symptoms which characterize enlarged prostate.

DIAGNOSIS.—When these concretions acquire considerable bulk, they may be felt by an examination with the finger introduced into the rectum. Should they project into the urethra or bladder (Fig. 1301), they might readily be mistaken for urinary calculi.

FIG. 1301.



Prostatic calculus.

* See an interesting paper on this operation, by Dr. Hunter McGuire, read before the American Surgical Association, 1888.

† See a paper on this operation, by the author, in the University Magazine for October, 1888.

Unless, however, they can be detected by digital tact through the walls of the bowel, the recognition of their presence must be plainly inferential.

TREATMENT.—As long as these calculi occasion no great suffering, nothing more than palliative treatment will be required,—avoiding everything which is calculated to add to the local irritation, as horseback-riding, fecal accumulations in the rectum, and acidity of the urine, using, when the rest is much broken, a rectal suppository of opium at bedtime. These calculi, when they attain any considerable size, may, by ulceration, find their way into the urethra, the bladder, or the rectum. When the suffering attending their presence becomes sufficiently important to justify operative measures, a staff should be introduced into the bladder and the perineum and prostate laid open as in median lithotomy,—not, however, extending the incision into the bladder,—and all the concretions which can be discovered should be extracted.

CHEESY OR TUBERCULAR DEPOSITS IN THE PROSTATE do not exist independently of similar deposits in other structures, as the bladder, kidneys, testes, and seminal vesicles. They are occasionally met with in strumous subjects. The degeneration commences in the glandular portion of the prostate, and the deposits, which are peri-tubular, soften down, completely disorganizing its structure, and causing numerous abscesses, which discharge, leaving cavities resembling the vomicae in tubercular disease of the lungs. This degeneration may occur at almost any period of life, though no cases have been observed earlier than eleven years of age.

SYMPTOMS.—If, in a scrofulous patient, irregular masses can be felt over the surface of the prostate, with indurated, irregular prominences in the vesiculæ seminales, the existence of this cheesy degeneration is rendered highly probable.

As this disease is only one expression of a deep constitutional vice, the prognosis is necessarily unfavorable.

TREATMENT.—The remedies which are indicated are such as are calculated to improve the nutrition, as cod-liver oil, iodide of iron, and good food.

CANCER OF THE PROSTATE is almost invariably secondary to carcinomatous disease in other parts of the body, and even then is exceedingly rare. The medullary or encephaloid variety appears to be the most common, though the scirrhus, melanotic, and colloid forms of the disease are said to have been observed. At no period of life is the prostate exempt from this malignant degeneration. The disease sometimes previously begins in the epithelial lining of the testicle.

SYMPTOMS.—There are no symptoms which reveal with any certainty the existence of cancer of the prostate, but there would be plausible grounds for suspecting its presence if, in connection with medullary disease elsewhere and with frequent and painful urination, there should be found irregular, soft projections over the surface of the prostate, when examined with the finger in the rectum.

TREATMENT.—Nothing can be done for the permanent relief of cancer of the prostate. The symptoms may be palliated by the use of the catheter or by a supra-pubic cystotomy when the obstruction interferes seriously with the passage of the urine, and by using opium suppositories and alkaline drinks. Tonics of iron, of arsenic, and of quinine, with proper food, will be required to keep up the strength.

CYSTS, in the strict sense of the term, are seldom, if ever, found in the prostate. The nearest approach to affections of this kind is seen in the dilatation of the ducts and acini of the follicles by concretions formed from the prostatic secretion, and in the smooth-walled cavities which formed the bed for calculi or remain after the discharge of an abscess.

HEMORRHAGE.—The prostate, though not supplied with vessels of any magnitude, may nevertheless be the source of considerable hemorrhage, which may originate in an unusual plethora of its vessels, or in consequence of the rude use of instruments in the urethra.

TREATMENT.—Rest in the recumbent position, cold applied to the perineum, and full doses of ergot are the remedial measures to be adopted.

Retention of Urine.

The causes which give rise to retention of urine are *mechanical, pathological, congenital, psychical, miasmatic, and therapeutical.*

SYMPTOMS.—Retention of urine is peculiarly distressing. When complete, there is a sense of fullness or distention experienced in the hypogastrium; the patient has a constant desire to micturate, accompanied by pain and vesical tenesmus; and as the accumulation increases the extreme mental distress, anxiety, and nervous excitement become almost uncontrollable. The local signs of urinary accumulation are a circumscribed swelling in the hypogastric region, with corresponding percussion dullness, and a fullness which may be felt in the inferior part of the pelvis by introducing a finger into the rectum or the vagina. In incomplete retention, there may be constant dribbling of urine, or the latter may escape at short intervals for a few moments in a very fine stream.

If the case is allowed to progress without being relieved, constitutional symptoms arise of an alarming character. Rigors occur alternately with flushes of heat, and are followed by hot skin, feeble and frequent pulse, a dry, dark tongue, with a urinous odor emanating from the breath and skin, accompanied by extreme exhaustion, and, finally, hiccough, wandering, and stupor, which betoken the near approach of death, a termination which rarely occurs earlier than the seventh or eighth day.

DIAGNOSIS.—The signs of retention are so characteristic and obvious that it seems almost incredible that any medical man should fail to recognize the true condition; and yet I have many times witnessed the most egregious errors committed in this matter,—some, I regret to say, which cost the patients their lives. One of the most common sources of error—that which is most likely to lead an inexperienced man astray—is the *constant dribbling* of urine which is often present in retention. This, which is the overflow from distention, is supposed to be inconsistent with the presence of a serious accumulation, and hence the failure to realize the mischief which is going on. The records of surgery are full of mistakes in diagnosis with regard to urinary retention. It has been confounded with ascites, ovarian dropsy, pregnancy, pelvic tumors, and abscess.

The use of the catheter constitutes an easy method of clearing up all obscurity, and renders a mistake inexcusable.

In large accumulations the bladder rises from the pelvis, and becomes very prominent above the pubes. It may reach some distance above the umbilicus,—even, it is alleged, to the diaphragm. The effect of such a change of position is to put to a severe strain the reflections of the pelvic fascia, which serve as the vesical ligaments, and to elongate the urethra so that a catheter considerably longer than the ordinary instrument may be required in order to reach the bladder. When the distention is great it will be best to draw the water slowly, so as to give time for the walls of the organ to recover their contractility, or to remove the accumulation at two different catheterizations, a few hours apart. Neglect of this precaution has been followed by vesical hemorrhage, from the loss of support to the vessels of the mucous membrane. Even death from syncope has ensued on the sudden abstraction of a large collection of urine.

Fatal terminations of retention can rarely be attributed to rupture of the bladder, though its walls, thinned under the effects of mechanical distention, finally become inflamed, softened, and even gangrenous. As long as the valvular arrangement which exists at the entrance of the ureters remains unimpaired, the damage is confined to the bladder; but when those openings begin to yield, the urine is forced back, and the ureters become dilated. The typhoid

symptoms which are soon developed in neglected retention are due to the constituents of the renal secretion re-entering the blood and rendering it unfit for the purposes of nutrition.

The amount of urine which the bladder is capable of containing without serious lesion is almost incredible. I am certain that I have in two instances removed not less than two gallons. Boyce mentions the case of a patient who suffered from retention as a consequence of paralysis, and from whose bladder after death eighty pounds of urine were removed, which would be equivalent to ten gallons by measure.

RETENTION FROM PRIMARY MECHANICAL CAUSES is occasionally met with the most common being that which arises from coagula of blood within the bladder, impaction of the foetal head in the cavity of the pelvis, pressure of the gravid uterus, or large fecal accumulations in the rectum.

When, in consequence of renal or vesical hemorrhage, blood-clots accumulate in the bladder, obstructing the flow of urine, it is well to wait a short time before resorting to instrumental interference. The urine may find its way through the coagula, and be discharged voluntarily, or may rise to the surface on their subsidence and be easily drawn off. It is also capable of dissolving the clots, to some extent, so that they can be expelled in fragments.

When it becomes necessary to interfere in consequence of the extent of the accumulation, the ordinary catheter will prove almost useless, as the small openings at its end are soon occluded by the intrusion of small masses of coagula, which prevent the entrance of the urine. An instrument having at its vesical extremity two large eyes, one on each side, and not directly opposite each other (Fig. 1302), will serve a better purpose.

FIG. 1302.



Author's blood catheter.

This catheter having been introduced into the bladder, should the water not flow, the nozzle of a large syringe may be fitted to the extremity, and a column of air or tepid water forced through its canals, by which the clots can be displaced. The syringe can also be used as an exhaustor, by drawing the piston back, thus favoring the escape of both blood and urine.

Or a catheter may be used like that of Professor Gross, in which the opening is situated at its end, which is closed by an obturator. The latter is withdrawn after the instrument enters the bladder. When the retention is due to pressure either from the gravid uterus or from the foetal head, and demands immediate relief, the difficulty must be overcome by pushing up the one or the other and introducing the catheter. When fecal accumulations in the rectum prevent the passage of the urine, as will frequently happen in old persons deficient in muscular expulsive power, the bowel will require to be cleared by injections or by the scoop.

The retention may be *complete* or *partial*. In the first not a drop of urine escapes; in the second there may be constant dribbling or the frequent passage of a small stream.

PATHOLOGICAL CAUSES OF RETENTION.—Under this head are included strictures of the urethra, or the congestion and spasm incident to their presence, hypertrophy of the prostatic body, concussion of the brain and spinal marrow,

analysis, perineal abscess, uterine growths, exostosis of the pelvic bones, cysts, and spasm.

TREATMENT.—When the retention arises from a congested stricture, there is frequently associated with the latter more or less muscular spasm. To ascertain definitely the date of the retention, the patient should be pointedly interrogated. A person laboring under stricture may suffer from partial inability to pass the urine for several days before complete stoppage occurs, or he may have been deeply intoxicated, and, therefore, not sensible of the duration of the accumulation. When satisfactory information cannot be obtained from the patient, the surgeon must be guided in his decisions by the size of the vesical tumor.

If the case is very recent, there is no necessity to rush precipitously to the use of the catheter. On the contrary, it may be desirable to delay for a short time all operative interference, until the local irritation and swelling have been somewhat subdued. Much may be done in such a case by restoring the morale of the patient, assuring him that there is no necessity for alarm, that all apprehensions of rupture are groundless, and that relief will be obtained in a short time. If an attempt to pass an instrument is made too soon, it is able to provoke an increased degree of spasm, and thus add to the existing obstruction.

A hot hip-bath, a few leeches and hot fomentations applied to the perineum, and an injection of laudanum and tincture of belladonna (laudanum, gtt. xl; tinct. belladonna, gtt. xx) thrown into the bowel will next be indicated. Frequently nothing more is required; in two or three hours the swelling begins to subside, the neck of the bladder relaxes, and the patient is pleasantly surprised to find that now a few drops of water can be passed, the amount gradually increasing little by little, until finally a fair stream is obtained, and the case terminates without catheterization at all. Should this result, however, not follow the measures which have been detailed, or if the retention has already existed for eight or ten hours, it will not do to procrastinate. The time does not preclude the hip-bath and an anodyne injection or suppository; these will still be useful as aids in the work of relief; but more is demanded. The catheter must be passed.

The probabilities of success will be greatly increased by the use of an anesthetic. After the patient is brought under the influence of ether, a small catheter (No. 4 or 5) should be passed down the urethra, until the stricture is encountered. Probably, after a little detention and after careful manipulation, the obstruction will be cleared, the bladder reached, and the urine removed. Under such circumstances, it will be well to tie the instrument and allow it to remain for twenty-four hours, when the attack will have subsided.

Should the surgeon be foiled in his attempts to pass the coarctation, a long, filiform bougie may be next employed, and, if he succeeds in getting beyond the contraction, it can, by being passed through the catheter, be used as a guide for the safe conduct of the latter into the bladder.

Prostatic Enlargement.—Next to stricture, enlargement of the prostate constitutes one of the most common causes of urinary retention, the subjects being in the main old men. The obstruction which in these cases interferes with the discharge of the urine may be a permanent one, or it may only arise when, in consequence of cold or the abuse of stimulants, the prostate becomes swollen. The difficulty which is encountered by the catheter is at the neck of the bladder, from the acute deflection of the canal.

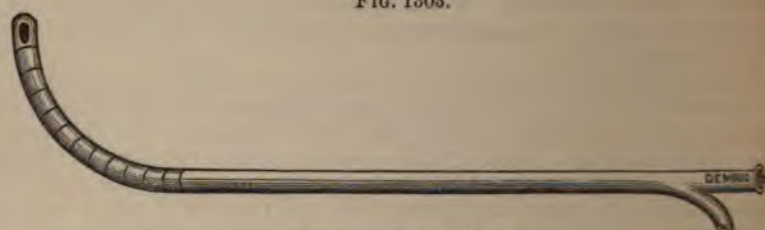
Generally in cases of this nature the soft catheter will be found most satisfactory, and especially the Mercier (Fig. 1298), or that with an elbow. The presence of this fixed point to a flexible shaft confers a mechanical advantage upon no other instrument possesses to the same degree, and by which it can more readily surmount with great ease abrupt obstructions in the course of the urethra.

It will, however, often be necessary to resort to the long English catheter, which may be used either with or without a stylet, and the

extremity of which must generally be bent to quite an abrupt curve in order to mount over the obstruction. Sometimes the silver catheter will answer a better purpose than any of the soft instruments.

With the object of surmounting these short curves, such as are encountered at the prostatic body, metal catheters with flexible extremities have been devised, of which there are three varieties, that of Squire, of Elmira (Fig. 1303), that of Levis, and that of the younger Gross. (Fig. 1304.)

FIG. 1303.



Squire's vertebrated catheter.

FIG. 1304.



Gross's spiral catheter.

The vesical extremity of Squire's catheter is formed by a series of metal imbricated caps, linked together with wire; that of Gross has a spiral coil of wire interposed between its shaft and extremity. Articulated instruments are liable to corrode and to break while being introduced into the bladder, which constitutes a valid objection to their use.

When the catheter does not readily surmount the prostatic elevation, it can be greatly assisted in doing so by the pressure of a finger inserted into the rectum and acting against the instrument through the membranous part of the canal. The handle of the catheter in such cases will often require to be more depressed after the point passes beneath the pubes than in ordinary catheterization. When the soft catheter is used, its extremity can often be coaxed over the seat of obstruction by withdrawing the stylet a very short distance, thus increasing the curve at the end of the instrument.

When the obstruction arises from a sudden congestion or swelling of the prostate, the catheterization may be rendered less difficult by premising a hot hip-bath.

Gonorrhœal urethritis, more particularly in its later stages, is sometimes followed by retention, especially if there has been exposure to cold, a too free use of stimulants, or any sexual excess. The obstruction is located in the prostatic part of the canal, and is due to congestive swelling.

Cystitis will, in rare instances, provoke retention. This may not at first be understood by the medical attendants, as it will probably occur in cases where the bladder has long been so intolerant of the presence of the urine that it will not retain more than a few tablespoonfuls at a time, and the patient is, consequently, urinating every half-hour. The pain and distress when the neck of the bladder, from swelling or spasm, refuses to allow the water to escape, are exceedingly severe, not from the amount of fluid which the bladder contains, but from its irritating effects on the supersensitive vesical walls. The catheter will usually be required for relief.

Retention as a result of concussion is very common, and is due to a loss of power in the muscles, both vesical and abdominal, which are concerned in the expulsion of urine. If the injury has been very severe, it may after a short

time be followed by incontinence. The catheter should be employed three or four times in the twenty-four hours until the innervation of the muscles returns, which, in ordinary cases, soon follows the recovery from concussion.

When the obstruction to the passage of urine is produced by the pressure of a *perineal abscess*, the indication is to evacuate its contents, and, if this does not remove the disability, then to pass the catheter.

Uterine tumors, cysts, exostoses, and other *pelvic growths*, which occasion retention by pressure, must be treated tentatively or radically, according to the feasibility of their removal. Temporary relief can often be obtained by changing the position of the tumor, either by digital pressure or by posture, when the bladder or the urethra will be relieved, for the time being, of the pressure. This may be necessary to the easy introduction of the catheter.

Spasmodic retention may be either traumatic or idiopathic. The former is frequently seen to follow the rough use of instruments in the urethra, the ligature of hemorrhoids, fractures, and severe surgical operations. The latter arises from exposure to cold and dampness acting on a highly sensitive organization, and producing swelling of the prostatic urethra. When the retention is traumatic, the catheter is generally required for relief; but when it is idiopathic, a hot bath, followed by an opium suppository or an enema of laudanum, will often render the use of the instrument unnecessary.

Congenital causes of retention include any malformations which may prevent the escape of the urine, as an imperforate prepuce or an atresia of the meatus, in which case circumcision or incision will be required.

PSYCHICAL CAUSES.—There are some persons who are so constituted that they are never able to empty the bladder in the presence of others. From this extreme sensibility the urine is allowed to accumulate until the organ becomes over-distended, when it is rendered incapable of contracting on its contents, in the same way that the uterine contractions are often prevented by a large amount of the liquor amnii.

A gentleman who traveled frequently between Pittsburg and Philadelphia was in the habit of coming to my office on reaching the latter place in order to be catheterized. The idea of entering the water-closet in the presence of other passengers was so repugnant to his feelings that the bladder became helpless from over-distention.

I have several times known persons who, under excitement, were unable to evacuate the bladder without the persuasion of a stream of water flowing in a wash-bowl. I recall also an instance in which a strong, sturdy man was unable to urinate without assuming the feminine position of squatting. Cases of a kindred character are designated by Sir James Paget as "stammering of the bladder."

Among the psychical causes of retention is that sometimes called *hysteroid*, peculiar almost entirely to women. The physician who is not entirely conversant with these freaks may be subjected to a great deal of anxiety, annoyance, and loss of time by catering to the sham and drawing the water for a long time. In a case suspected to be of this nature a careful examination should be made, to learn if the eccentric behavior of the organ can be traced to any mechanical or other cause, when, if satisfied that none such exists, after drawing the urine, a repetition of the operation may be avoided by declining any further interference. The patient then generally manages to relieve the retention by her own voluntary efforts.

MIASMATIC RETENTION is to be inferred when the inability to urinate occurs periodically, in which case quinine, arsenic, and piperine are the remedies indicated during the intervals between the paroxysms, and the catheter should be used to relieve the immediate urgency.

THERAPEUTICAL RETENTION.—There are certain drugs which, from their tendency to cause irritation at the neck of the bladder, produce retention of urine, by creating congestive swelling and spasm at the urethro-vesical opening. Such are cantharides and spirit of turpentine. A hot hip-bath and an anodyne enema, with mucilaginous diluent drinks, soon overcome the

difficulty. Should a voluntary evacuation of the urine not follow their use, a soft catheter may be employed.

FORCED CATHETERIZATION.—In difficult cases, where it has been found impossible to reach the bladder by ordinary measures, there remain the alternatives of forced catheterization or tapping the bladder. By forced catheterization the instrument, after having reached the neighborhood of the bladder, is pushed onward by main force and in the direction of what is believed to be the proper course until the bladder is reached. This is most rash, dangerous, and culpable surgery. The point of the catheter is as likely to pass into the recto-vesical space or into the pelvis as into the bladder; if it reaches the latter it will probably be by some circuitous route, and the dangers of urinary infiltration, abscess, and fistula will be scarcely less than those arising from the retention.

When, therefore, the alternative is presented, there can be no doubt about the propriety of tapping; though, I repeat, the operation will seldom be required in the hands of a skillful surgeon.

While making this statement, it must not be concealed that there are many excellent practitioners who have had little experience in dealing with intractable strictures and the urinary complications which so often attend their presence, and in such cases it would be unreasonable to expect that address and success in the use of the catheter which are attained by the hospital surgeon. Hence the dogmatism which sometimes characterizes surgical writings with reference to the uniform feasibility of catheterization in all cases of retention may operate not only to the injury of a patient, by inducing the less skillful to persevere too long in unsuccessful efforts with the instrument (when the aspirating trocar could be successfully substituted), but may also tend to expose the reputation of a medical man to unjust reflections and censure.

TAPPING THE BLADDER.—The bladder may be opened above the pubes, through the pubic symphysis, beneath the pubes, through the perineum, and through the rectum.

The simplest plan, and one requiring very little skill, is the supra-pubic operation with a Dieulafoy aspirating trocar. The bottle being exhausted of its air, a capillary trocar and canula are pushed into the distended bladder two or three inches above the pubes, exactly in the median line, or *linea alba*, and carried onward until all resistance ceases. The canula being now connected with the flexible tube of the bottle and the trocar withdrawn, the urine will flow into the receiver.

The operation can be repeated several times if necessary; though it is always proper, before resorting a second time to aspiration, to make another effort at catheterization.

In the formal operation of the supra-pubic tapping the patient is placed in the recumbent position and the hair removed from the pubes. An incision is made through the skin in the median line above the pubes, two lines in length. A curved trocar (Fig. 1305) is then pushed through its walls in a direction backward and downward, while the organ is supported on either side by the hands of an assistant. The canula may be retained, or a gum catheter may be introduced through its canal before the former is removed, and can be kept in place by a strip of adhesive plaster or by tapes leading to the perineal strips of a T-bandage. A double canula, in which one tube slides within another, has been devised for the same purpose. This plan, from its simplicity, should, in all ordinary cases requiring tapping, be adopted.

Tapping through the rectum.—Next in facility of execution is the operation through the rectum. The bladder is opened by this route in a triangular space at its base, which is devoid of peritoneal covering, and which is bounded in front by the prostate body and on each side by the vasa deferentia and the seminal vesicles. This operation is performed by means of a long curved trocar and canula. The rectum being emptied by an enema, the patient is placed on a table in the lithotomy position and with the hips projecting over

its edge. The surgeon, oiling the index finger, introduces it into the rectum, and places its tip on the middle of the posterior border of the prostate body.

FIG. 1305.



Trocar for tapping the bladder.

Taking now the trocar in the other hand, with its point drawn into the canula, the instrument is carried along the side of the finger as a guide until its extremity rests against the bladder, immediately behind the centre of the prostate body. The point of the trocar is now thrust out of the canula, when, by depressing the handle, the instrument is made to penetrate the rectovesical walls and enter the bladder, which will be announced by the absence of resistance.

As the trocar is withdrawn, the canula should at the same time be forced farther in, when, on separating the one from the other, the urine will escape with a gush through the tube.

After the bladder has been emptied, the canula may be withdrawn; or, if the urethral obstruction is of a character which renders successful catheterization improbable, it may be retained *in situ* by a T-bandage.

Though the wound made in opening the bladder through the rectum usually heals kindly, the procedure is not wholly without danger. It has been followed by abscess, urinary infiltration, fecal extravasation, and other evil consequences, some of which may not unjustly, I think, be referred to the unskillful manner in which the puncture was made.

Tapping the bladder through the perineum, if executed with care, is also a simple operation, and attended with little danger. The plan is a very ancient one, and is described by Richard Wiseman as Molins's operation. It has, however, been improved as well as simplified by Mr. Cock, a surgeon of London. The instruments required are a long, narrow, sharp-pointed, double-edged bistoury, a large probe-pointed director, and a catheter.

The rectum being cleared of all feculent accumulations, the patient, having been first etherized, is placed in the lithotomy position, with the body and pelvis exactly in line. The surgeon, oiling the finger of his left hand, passes it into the rectum and plants it accurately against the apex of the prostate body. The knife is now entered at the median line or raphé of the perineum, and carried, without indecision, steadily onward until its point is felt at the tip of the finger which is in the bowel.

By carrying the handle of the bistoury forward and backward the external wound may be enlarged, reaching in the posterior direction within half an inch of the anus. If the operator is assured that the tip of the finger rests against the anterior surface of the prostate, and that the point of the knife is similarly placed, he has only to give it a slight inclination to one side or

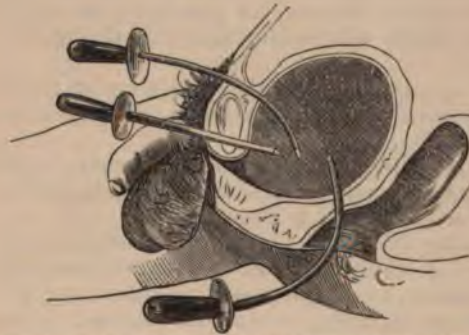
the other, and carry it boldly onward, in order to enter the urethra at the juncture between the membranous part of the canal and the prostatic gland.

Withdrawing the knife, but retaining the finger in its position, the operator next introduces the director through the incision, and, guided by the finger into the urethra, passes it on into the bladder. The catheter can now be introduced along the groove of the director, and after the removal of the latter may be retained in the bladder by means of a T-bandage.

After thirty-six hours the instrument should be withdrawn, and an effort made again to introduce the catheter by the natural passage, when, if successful, the perineal opening may be allowed to close. If, on the other hand, the stricture continues to remain impassable, it will be better to convert the extemporized opening into a perineal section, executed according to the rule presented under that head, and in this manner remove the urethral obstruction.

Infra-pubic puncture of the bladder has been practiced by M. Voilemier: a trocar and canula were pushed underneath the arch of the pubes, alongside of the suspensory ligament of the penis, while the latter organ was drawn strongly towards the perineum, the point of the instrument being directed downward and backward after passing the pelvic arch, in order that it might enter the bladder a little behind the junction of its body and neck, and in that space where it is not invested by peritoneum. Though the wound rapidly healed and the operation was entirely successful, no inference can be drawn from a single case as to its relative value.

FIG. 1306.



Tapping the bladder above the pubes, through the symphysis, and through the rectum.

Interpubic puncture, which was originally suggested by a physician of New Jersey, Dr. Brander, is performed by a trocar and canula, the instrument being thrust through the symphysis pubis, in a direction backward and downward, while the patient is in the recumbent position, and carried onward until the bladder is penetrated. After this is accomplished, the trocar is removed, and the canula, before being withdrawn, is employed as a guide through which to pass a gum catheter.

There are a few cases of vesical tapping by this method, but it is exceedingly improbable that either the subpubic or the interpubic operation will meet with any marked favor when the aspirating trocar of Dieulafoy can be used with such great safety and ease.

Diseases and Injuries of the Scrotum.

Wounds of the Scrotum may be *incised, contused, lacerated, or gunshot.*

Incised wounds are rarely seen except when made by the knife of the surgeon or in attempts at self-castration.

Contused and lacerated wounds are frequently witnessed among mechanics, builders, and railroad-men, in consequence of the casualties to which they are exposed by falling timbers and by being caught between cars.

Gunshot wounds of the scrotum are often complicated with similar injuries of the urethra, in consequence of which extensive sloughing is likely to follow from the extravasation of urine.

Incised and lacerated wounds, after the ligation of any bleeding vessel, require to be brought together by the interrupted suture. They heal generally

great rapidity, in consequence of the contraction of the dartos structure, it favors accurate apposition and leaves no vacuities in which serum or blood can collect. After the stitches have been introduced, the wound should be covered with a water-dressing or with carbolated oil, and the scrotum firmly supported. In thirty-six or forty-eight hours the sutures can be removed.

When the testicle is forced through a small rent or wound in the scrotum, an abscess is occurred, unless immediate relief is at hand the contraction of the skin may produce such a degree of strangulation of the gland as to require the wound shall be dilated or enlarged by incision before the testis can be removed.

The same difficulty is said by Gosselin to follow even large wounds of the scrotum, if allowed to remain unclosed for some time, by the swelling of the testicle and its adhesion to the wounded integument.

I have never witnessed anything of this kind.

Contusions of the scrotum are followed by a diffused purple discoloration, and the extravasation of venous blood through the loose connective and cellular tissue which underlies the skin.

Cold lotions of lead-water or of ice-water, and elevation of the part, will fully justify the indication.

Sometimes after a severe blow or kick on the scrotum a very large amount of blood may escape, forming a uniform enlargement or swelling, which might be mistaken for a similar collection in the tunica vaginalis. There is, however, in the first no fluctuation at any time. The swelling is firmer, even than the testicle, in consistence, and the parts are discolored,—signs which do not belong to uncomplicated hæmatocele of the tunica vaginalis.

It is possible, however, for both to exist at the same time, the latter being produced by the same violence that causes the scrotal extravasation.

The treatment does not differ from that proper to simple contusion. In the case of the effusion, even though it be considerable, will be gradually removed by the use of leeches and absorbents, leaving the parts unharmed.

In consequence of the contusion and extravasation, the vessels are so pressed as to embarrass the circulation in the scrotum, abscess or even gangrene may follow. Should such a termination be threatened, the parts should be surrounded with warm-water fomentations, or, what is better, with flaxseed-meal poultices, giving exit to any purulent collections which may form, and favoring the separation of sloughs.

Incised wounds of the scrotum, as in other parts of the body, heal by open granulations, and require nothing more than plain water-dressings. They are slow in cicatrization, in consequence of the disturbance to which they are subjected by the frequently recurring contractions and relaxations of the dartos muscle, which occur in consequence of the sloughing incident to such wounds.

Should the scrotal or perineal urethra suffer in common with the scrotum, urinary extravasation into the latter may be anticipated: to prevent this the urine should be drawn with the catheter, or, if this has been neglected and the extravasation has occurred, it will be necessary to lay the scrotum open by a free incision, in order to draw away the urine and prevent sloughing. *Prurigo and eczema of the scrotum* are quite common affections. They are met with at all ages and at all seasons, though more common during the summer than during the winter months. These diseases are not limited to the scrotum, but extend to the inside of the thighs, to the perineum, and occasionally to the hypogastric region. The causes which give rise to these affections are, in children, phimosis, stone in the bladder, and contact with the urine, as in incontinence, atony of the bladder, etc.

In old men the cause is to be sought for in some derangement of the secretory organs; and in this class of persons the disease often proves most obstinate.

The condition when due to prurigo is characterized by severe itching (which,

from its constancy, is peculiarly distressing) and by slightly-raised papules of a red color.

In eczema the eruption primarily begins by the formation of minute vesicles. In consequence, however, of the scratching, which is irresistible in both affections, the parts become excoriated, cracked, and covered with a thin discharge, which hardens into crusts. The skin becomes hypertrophied from the transudation which takes place into the papillary layer of the derma, and an unpleasant odor is emitted, partly from the discharge and partly from the perverted secretion of the sebaceous glands of the scrotal integument. With some persons the severe itching is paroxysmal or intermittent, appearing after they have become heated with exercise or warm in bed, not much inconvenience being experienced during the day or while the patient is at rest.

TREATMENT.—As a preliminary measure in the treatment, the cause must be carefully sought for. When associated with phimosis or with collections of smegma beneath the prepuce, the operation of circumcision or incision, and careful ablutions, will be demanded.

In elderly persons suffering from the disease the digestive apparatus will require attention. A few grains of blue mass followed by a gentle cathartic, a carefully-regulated and unstimulating diet, together with tonics, as quinine or iron, or the infusion of gentian, with the bicarbonate of soda, or the use of nitro-muriatic acid, form the course of treatment best adapted to correct the constitutional disorder. The local management of these diseases is also very important. The parts require to be carefully cleansed, for which purpose daily ablutions with hot water and carbolic acid soap or bran-water answer the best purpose. These must be followed by the application of a stiff oxide of zinc ointment. Frequently the value of this ointment is enhanced by incorporating with it a little tar ointment. In other instances, after bathing the scrotum with an alkaline wash, as a solution of the bicarbonate of soda or of borax, and drying the skin, calomel should be thickly dusted over the surface.

Citrine ointment, somewhat weaker than the officinal strength, has been followed by excellent results when smeared over the affected parts.

The severe itching is best relieved by a wash of carbolic acid and water (one drachm of the acid to six ounces of water), or by a solution of the bichloride of mercury (two grains and a half of the salt to three ounces of water), or by brushing over the scrotum liquor potassæ diluted with one-fourth water. Fumigation of the scrotum with sulphur or cinnabar has also been used with good effect for the same object. Patients who suffer from these affections will find it conduce to their comfort to lie on a hard bed, with light covering, and to refrain as much as possible from scratching the affected parts.

Parasites.—The pediculi pubis frequently find a habitat in the hair of the mons veneris and the scrotum. They are easily detected by the eye. Their eggs are deposited on the shafts of the hair, and can be recognized as small, knot-like bodies.

The remedy for these disgusting lice is mercurial ointment rubbed over the affected region; or a solution of the hyposulphite of soda (3iss of the soda to water 3ij) may be applied freely as a lotion. Corrosive sublimate (two grains to the ounce of water) will also destroy these parasites in their ova.

Varicose Veins.—The admirable support which is furnished by the dartos to the veins of the scrotum is unfavorable to the existence of varix; but where the tissues of the scrotum have become much relaxed, as in aged persons, or where they have been greatly stretched by large herniæ, or in bad cases of varicocele, I have several times witnessed well-marked cases of scrotal varix. The enlargement and tortuous disposition of these vessels are rarely

confined to one side, but extend to both (Fig. 1307), and in some instances a similar condition of the dorsal veins of the penis is witnessed.

The treatment is palliative, and consists in cold bathing and the use of a suspensory bandage.

Pneumatocoele, or Emphysema.—Air diffused through the connective and dartos tissues is always present in gangrene of the scrotum. It is sometimes produced artificially, as one of the tricks of mendicants and hospital malingerers. The distention is readily produced, and without pain, by making a small puncture through the skin of the scrotum, inserting a small tube into the opening, and blowing air into the underlying loose connective tissue. The crackling on pressure and the resonance on percussion are sufficiently diagnostic of the condition.

The air is gradually absorbed, or can be expelled by an incision through the integument of the scrotum, followed by the application of a narrow bandage from above downward.

FIG. 1307.



Varix of the scrotum.

Œdema of the Scrotum occurs both as a primary affection and secondary to disease in other organs which may interfere with the circulation.

As a primary condition it is seen in erysipelatous or other inflammation of the part, after the sting of a bee, in new-born children from local irritation, and occasionally in aged, debilitated persons.

The diseases which are influential in causing scrotal œdema are cardiac and renal dropsy, epididymitis, pelvic tumors, and inguinal tumors. I have seen it follow the use of the exploring needle in cases of hydrocele.

SYMPTOMS.—Œdema usually appears as a uniform, globular swelling, including the entire scrotum, and doughy or inelastic in its consistence. Pressure causes a slight depression, which remains for a very short time after the removal of the finger.

The swelling commences in the most dependent part of the scrotum, and as the serum accumulates in the subcutaneous connective tissue, it gradually rises, obliterating, as it does so, the normal rugæ of the integument, until the skin becomes pale, smooth, glossy, and translucent.

As the accumulation increases, the serum extends to the cellular tissue of the penis, the skin of which assumes very much the same appearance as that of the scrotum, the prepuce also becoming singularly twisted.

The diagnosis of œdema is not a matter of difficulty. The doughy, inelastic feel, the slight pitting on pressure, the semi-transparency of the skin, the obliteration of the natural rugæ, the shining, glossy appearance of the integument, and the bilateral nature of the swelling are sufficient to distinguish the affection from hydrocele, the only disease with which it is likely to be confounded.

In rare instances the œdema has been limited to one side, a fact which led Pott, on one occasion, to puncture the swelling with a trocar, under the impression that he was dealing with a hydrocele.

TREATMENT.—It is only when the distention of the skin is so great as to threaten its vitality that it is necessary to address any specific treatment to the parts, when it will be proper to make, with a large needle, two or three punctures through which the serum may drain away. Incisions should be avoided, as they are liable to be followed by sloughing. If the remedies which are addressed to the removal of the diseases on the existence of which scrotal œdema depends, prove efficient, the latter may be expected to disappear.

Inflammation of the Scrotum is not very frequently seen outside of hospital practice. It is rarely traumatic in its origin, nor do persons of strong, vigorous constitutions often suffer from an attack of this nature. Adults and aged individuals, especially those of intemperate habits, or who have been subjected to severe deprivation, exhausting employments, or bad usage, are the subjects most commonly attacked. The inflammation is erysipelatous in its character, and may be developed by the irritation consequent on the dribbling of urine, or from a pimple which has become inflamed by scratching. The skin of the scrotum grows dusky red, swollen, and cedematous. The corrugations of the integument disappear, and the parts assume a smooth, shining appearance. The swelling is not limited to the scrotum alone, but extends to the penis, insides of the thighs, and inguinal regions, and is accompanied with thirst, rigors, a hot, dry skin, coated tongue, and other signs of febrility. In consequence of the great abundance of loose connective and muscular tissue underlying the skin of the scrotum and the dependent position of the latter, the swelling and œdema are necessarily very marked, as both are favorable to a free and sudden transudation of serum. It was from these peculiarities, no doubt, that Mr. Liston,* who has recorded a number of such cases, adopted for the disease the name "acute anasarca of the scrotum."

In favorable cases these symptoms gradually subside by resolution, or terminate in suppuration, without causing any serious structural damage to the scrotum. But in the graver variety of the affection the infiltration is so rapid and so large, and subjects the vessels to such severe pressure, that the subcutaneous tissues are extensively destroyed by mortification, without much suppuration, leaving, after the separation of the sloughs, the testicles entirely uncovered and a portion of them gangrenous. Twice have I seen almost the entire scrotum destroyed. The devastation is accompanied by a feeble pulse, a dry, dark tongue, great exhaustion, retention of urine, and the other symptoms of a typhoid state of the general system.

DIAGNOSIS.—The only affections with which this inflammatory condition of the scrotum can be confounded are urinary extravasation and œdema. From the first the distinction may be established by a previous history of stricture or of injury to the perineum, the difficulty that will be experienced in introducing a catheter into the bladder, and the precedent swelling in the perineum, all of which distinguish urinary infiltration from rupture of the urethra.

In simple œdema of the scrotum there is little tenderness and no constitutional disturbance.

PROGNOSIS.—Though the disease occasionally proves fatal in defiance of the most judicious treatment, yet, generally, patients recover after a somewhat tedious convalescence.

TREATMENT.—The scrotum should first be elevated by placing underneath it a soft cushion, and should then be covered with a warm lotion of lead-water and laudanum. If the bowels are not freely open, a gentle cathartic, preceded by a few grains of blue mass, will be indicated; while, with a view of allaying febrile excitement, the neutral mixture may be administered every two or three hours. Should the disease tend to a favorable termination under this plan, it will have reached its culmination in the course of three or four days, from which time the swelling, œdema, and other symptoms will undergo a steady declination, until, in the course of ten or twelve days, all traces of the disease (except, perhaps, some slight œdema and thickening of the integument, with desquamation) have disappeared.

When, however, there is great tension of the integument, with the signs of suppuration, or if in connection with this tension the skin becomes dark and discolored, threatening mortification, there will be an urgent necessity for making two or three incisions at the most dependent portion of the scrotum, extending through the integument and the subcutaneous tissue, in order to

* *Medico-Chirurgical Transactions*, vol. xxii.

unload the latter of the inflammatory products, and thus prevent, or at least limit, the sloughing, after which the warm-water dressings or poultices should be applied. When sloughing does occur, laying bare the testicles, the best local application will be a flaxseed-meal poultice, having a little yeast spread over its surface, to correct the odor emanating from the dead tissue, always observing to wash the parts well with a solution of permanganate of potash and to pick away any loose sloughs before applying the poultices.

As soon as all the dead tissue has been detached and granulation has commenced, a dressing of sweet oil and carbolic acid may be substituted for the poultices until cicatrization has been completed.

Nor must the general treatment be overlooked. There will be an imperative necessity for the administration of tonics and stimulants, as quinine and iron, wine-whey, milk-punch, milk, beef-tea, eggs, and such other articles of nourishment as the patient may be able to take.

Mortification of the Scrotum is occasionally witnessed independent of an inflammatory cause. It may result from a severe scald, from embolism of the supplying vessels, or from frost-bite. Curling has seen one instance of the latter, and Sir Astley Cooper mentions a second, in the person of a soldier who was much exposed to intense cold during the retreat of the army in the Netherlands, under the Duke of York. Professor Gross has seen a case of idiopathic sloughing in an infant two weeks old, which destroyed a circumscribed portion of the scrotum down to the tunica vaginalis.

From whatever cause the mortification arises, the system will demand a generous support by tonics, stimulants, and food; and, with a view to effect a rapid separation of the dead tissue, warm poultices, spread with the compound resin ointment, must be applied, and the parts should be thoroughly cleansed and deodorized, at each renewal of the dressing, with lotions of permanganate of potash or carbolized water, until granulation begins, when the carbolated oil dressing will answer every purpose.

Even when the testicles and cords have been completely denuded I have seen the destruction entirely repaired by the reproduction, through granulation and cicatrization, of a new scrotum, somewhat different from the original (especially in the absence of the dartos muscle), but still sufficient for the purpose of protection.

Redundancy of the Scrotum is usually the effect of extreme stretching from large varicocele or hernia. It will rarely demand operative interference, cold ablutions, with a suspensory bandage, being quite sufficient to make the patient comfortable. Should anything more radical be required, the object can be obtained by raising transversely a sufficient duplicature of the scrotal tegument and cutting it away with the knife, when the edges of the wound, after all the vessels have been secured, must be brought together by several interrupted sutures, and the part covered with a water-dressing and kept well supported until union has taken place.

Tumors of the Scrotum.

The tumors which are met with in the scrotum are *cystic*, *fatty*, *fibrous*, *carcinomatous*, *enchondromatous*, and that hypertrophy known as *elephantiasis*.

Cystic Tumors are of two kinds, the one consisting of a dilated sebaceous follicle and containing a cheesy-looking matter, and the other a wall of densely compacted connective tissue surrounding an oval or irregular-shaped cavity containing a transparent serous or a yellow viscid fluid. (Fig. 1308.)

These tumors may possibly have a common origin in the sebaceous follicle, but their infrequency and the limited number of observations which have been made leave some uncertainty as to the manner of their formation.

These tumors are commonly multiple, several existing in the scrotum at the same time. They vary in size from a grain of shot to a hen's egg.

Cases of this disease have been observed by Mr. Crompton,* of Birmingham, England, by Barechet,† and by Fleming.

FIG. 1808.



Section of cystic scrotal tumor.—From Curling.

of the tumor cannot be distinguished, are not easily recognized.

The disease may be associated with a large deposition of fat over the abdomen, continuous with the scrotal mass, as in Gray's case, described by Mr. Curling, and also beneath the integument of the penis, as in the case described by Mr. Hogg and Sir Henry Thompson, recorded by the same writer.

The remedy is excision. Operations have been done by Dr. Kimball, of Lowell, Massachusetts, by Mr. Lane, of St. Mary's Hospital, and by Mr. Birkett.

Fibrous Tumors are rarely seen in the scrotum. When present, they occur as a single, dense mass of connective tissue, having a uniform, smooth surface, or in a number of small lobules connected together. They occasionally grow to a large size. In one of Mr. Paget's cases, the tumor weighed twenty-four pounds; in another, mentioned by Mr. Curling, the weight was twenty-three pounds; and in a third, recorded by Lesauvages, the tumor weighed forty-four pounds.

These growths are subject to singular transformations or degenerations. In an immense tumor of this kind, removed by Dr. Mott, a large amount of calcareous matter was found imbedded.

Fibromatous growths of the scrotum are distinguishable from all other affections in this region by their density, and by the healthy condition and absence of transparency of the superincumbent skin.

TREATMENT.—The proper remedy for fibrous growths of the scrotum when the disease is progressive is excision. The operation is generally followed by a permanent cure; though in a case operated on by Sir William Ferguson‡ the disease returned.

In almost all recorded cases of scrotal fibroma the patients were well advanced in life. In only one case, that of Mr. Lane, mentioned by Curling, was the patient very young, namely, two years and a half.

Enchondroma is the rarest of all tumors of the scrotum. One case is recorded by Dr. Kerr,§ an American surgeon in Canton, China, which occurred in a native, and which was excised. The growth was as large as a child's head, and when examined was found to consist of cartilage and true bone curiously intermingled.

Scrotal Calculi.—Concretions of this nature occasionally form in the scrotum, in consequence of a fistulous opening existing between the latter and the urethra or the bladder. The records of surgeons contain some singular in-

When these tumors continue to grow, they should be removed. The operations of this kind which have been performed appear to have been successful, as no mention is made of the recurrence of the disease.

Adipose Tumors of the Scrotum are rare. They are developed in the subcutaneous connective tissue, and consist of an aggregation of lobules of fat. They have a doughy feel, communicate a deceptive sense of fluctuation to the fingers on palpation, and, when the lobulated contour

* Curling on the Testes, p. 624.

† Archives Générales de Médecine, vol. ii. p. 70, 1858.

‡ Medical Times and Gazette, vol. xiv. p. 166.

§ North American Medico-Chirurgical Review, January, 1858.

nees of such formations. Mr. Holmes mentions a stone, which is in the Erwich collection, weighing eight ounces, which is represented as having been removed from the scrotum.

Von Graefe also speaks of a case in which a similar concretion, weighing twenty-six ounces, was discharged from the scrotum of a shoemaker, the tissues having given way in consequence of the weight of the concretion. These calculi are similar in composition to those which form in the pouches of a calculous bladder, being made up for the most part of uric acid or of phosphate of lime.

Elephantiasis Scroti, though rarely seen in the temperate latitudes of North America and Europe, is very common in India, Africa, Asia, Syria, Egypt, Arabia, China, the East and West Indies, and South America. The disease is of the same nature as the *Barbadoes leg*; and the same may be said of the hypertrophied labium of the female, which is frequently seen in tropical climates.

Heat and moisture exert a strongly determining influence on the produc-

FIG. 1309.



Neill's case of elephantiasis of scrotum and penis.

FIG. 1310.



Neill's case after operation.

tion of the disease, even in those countries where elephantiasis prevails. In India the large proportion of cases occur along the sea-coast and in the

neighborhood of Bengal. In Egypt the disease is limited to the Delta of the Nile.

The growth consists in a hypertrophy of the tissues of the scrotum, the penis participating in the disease. The surface of the skin becomes thickened and indurated, sometimes rugose, knotty, crossed with deep fissures, and covered with crusts.

The most striking change, however, is in the enormous hyperplasia and hypertrophy of the subcutaneous connective tissue, which is white, dense, and callous, cutting almost like cartilage, its lymphatics filled with a gelatinous fluid, rich in albumen, its veins enlarged and tortuous, remaining patulous when divided, and surrounded with colossal lymph-cells. In the posterior part of this hypertrophy the testicles lie imbedded, and in its anterior part the penis, when the latter is involved in the disease.

Masses of fat and earthy concretions are occasionally found scattered through the dense, fibrous mass, and in some instances erectile growths have been observed by Fayrer.

The testes generally remain sound. In consequence of the great weight of the tumor, the spermatic cords are necessarily very much elongated, and the cremaster is much thickened. In the cavity of the tunica vaginalis there is more than the normal quantity of fluid, frequently amounting to hydrocele. The shape of the tumor is usually pyriform or ovoidal (Fig. 1309),

SUB-FIG. 1.

FIG. 1311.

SUB-FIG. 2.



Skin of scrotum in elephantiasis Arabum, 225 diameters. Sub-Fig. 1 exhibits a section of the deep layer of the corium: *a, a, a, a*, bands of fibrous tissue, with numerous free nuclei, granular matter, and connective-tissue corpuscles interspersed through its meshes; also, cells with two nuclei; *b*, walls of artery infiltrated with cells; *c*, cell mass and adipose tissue atrophied. Sub-Fig. 2, vertical section of epidermal and capillary layer: *a, b*, horny layer of epidermis, in a measure detached; *c*, rete mucosum; *d*, cylindrical cells which contain much pigment; *e*, papillary layer, with cell infiltration and the remains of capillaries, and entire absence of hair follicles and of sudoriparous and sebaceous glands. Below the papillary layer are enlarged lymph spaces, *f, g, h*; *k*, blood-vessels, their walls thickened and fibrous.

having a broad, pedunculated attachment to the body, the skin being drawn

from the hypogastrium and the perineum. Under the crusts which cover the surface of the growths are superficial ulcerations, which furnish a sanious discharge having an offensive odor. Very little inconvenience is experienced, except from the magnitude and weight of the scrotum, and from this cause the latter sometimes mortifies, leaving the testicles uncovered. Dr. Hendy mentions six cases which terminated in this manner.

Elephantiasis is a chronic inflammatory disease produced most probably by miasmatic influences, and affecting chiefly the lymph-vessels. The observations made by Lewis and by Manson on the presence in the blood of persons suffering from this affection, of filariæ, which are thought to give origin to the disease, are well worthy of perusal.

The microscopic appearances of the skin of the scrotum in the tumor removed by Dr. Neill are very well exhibited in the drawing prepared by Dr. Shakespeare (Fig. 1311), from which Sub-Figs. 1 and 2 have been taken.

Elephantiasis of the scrotum sometimes attains enormous dimensions. Titley's case, which is represented in the accompanying cut (Fig. 1312), weighed seventy pounds. Liston removed a growth of this kind weighing forty-five pounds. The remarkable case of Delpech, preserved at the old school of Montpellier, in the south of France, is said to have weighed sixty French pounds, or one hundred and sixty pounds avoirdupois. Baron Larrey speaks of one which weighed one hundred and twenty pounds; and several others might be mentioned in which the weight varied from fifty to one hundred and twenty pounds.

TREATMENT.—Very little can be accomplished by internal treatment. Iodide of potassium, iodine, arsenic, iron, quinine, and other remedies have been administered. As alteratives and tonics they are not entirely devoid of value. A removal from the district where the disease has been contracted to another climate is deemed by Fayrer to be the most efficient means of arresting the growth.

When the bulk of the tumor becomes so great as seriously to interfere with the comfort of the patient, the knife is the proper remedy. The operation is among the most formidable in surgery. Many patients have perished on the table, or a very short time after the excision has been completed.

A Chinaman, from whom Ashton Key removed a growth of this kind weighing upwards of fifty-six pounds, died immediately after the operation was over. The same result followed a case of excision in the hands of Mr. Liston. Mr. Wilks lost a case, the patient dying before the excision was finished, having been on the table nearly eight hours. This tumor measured nearly six feet in circumference, and was two feet five inches in length.

Dr. Esdaile, of Calcutta, has operated 161 times, with a mortality of only 5 per cent.; Dr. Ballinghall, of Bombay, 21 times, with 2 deaths; Dr. Fayrer, 28 times, with 6 deaths. The mortality following 113 operations done at the hospital of the medical college at Calcutta, during a period of eight years, was 18.58 per cent.

In this country the operation has been performed a number of times, the

FIG. 1312.



Titley's case of elephantiasis scroti.

operators being Bozeman, whose patient died two weeks after the excision, and Picton, of New Orleans, Thebaud, of New York, and Neill, of Philadelphia, all of whose cases recovered.

The sacrifice of the testicles to save time and blood, as once practiced, is wholly unnecessary.

Before beginning the operation the tumor should be elevated, in order to drain the vessels of their blood, during which time the anæsthetic can be administered. To render the operation as bloodless as possible, an Esmarch bandage should be applied to the mass from below upward. The tubing being next secured round the pedunculated base of the growth, close up to the pubes, the elastic roller can be removed, when the surgeon proceeds to dissect out the penis from the anterior and middle part of the mass, and the testicles from either side. A sound or catheter previously introduced into the urethra will serve to establish the locality of the penis. Any vessels which spring should be ligated or secured by forceps as the operation proceeds.

As soon as the testicles and penis have been isolated, the surrounding fibrous mass must be cut away, leaving only a sufficient amount to form three flaps, one anteriorly for the penis and one on each side for the testicles.

As these cases of elephantiasis are occasionally complicated with rupture, the surgeon must keep this fact before his mind. If present, the sac must be carefully detached from the tissues around. Dr. Ballinghall, in one instance, inadvertently cut into the sac of a hernia while excising an elephantiasis of the scrotum. After the tumor has been removed, the edges of the wound are to be drawn together by interrupted sutures, and dressed antiseptically.

Lymph Scrotum.—A form of modified elephantiasis described by Dr. Carter in 1861, and which has been studied by Dr. Manson and by Dr. Macleod, consists in an inguinal adenitis, preceded by fever of a miasmatic origin, and followed by an inflammatory enlargement of the scrotum and the testes. The inflammation of the scrotum ordinarily ends in suppuration, leaving the integument rough and indurated, with numerous vesicles scattered over its surface. When these vesicles open, a clear or milk-colored fluid is discharged having all the characteristics of chyle, and containing filariæ similar to those found in the blood of persons laboring under elephantiasis.

The inguinal glands along the line of Poupart's ligament and over the saphenous opening are greatly enlarged. (Fig. 1313.) The hypertrophy of the scrotum in this affection, however, is not so much due to hyperplasia of its connective tissue as to the dilatation of the lymph-vessels and the accumulation of lymph in the papillary and deeper layers of the skin. This is shown by what follows the puncturing of the vesicles, the swelling rapidly subsiding and shriveling as the fluid drains away.

A case of lymph scrotum was brought before the Philadelphia County Medical Society by Dr. Styer. There was no enlargement of inguinal lymph-glands; the scrotum was dotted over with wart-like vesicles, which, when they opened spontaneously, or were punctured, furnished a milk-colored fluid like chyle, which continued to flow until the entire lymph-system of vessels was emptied and the patient became weak and faint. The fluid contained no filariæ.

The disease is met with in China and in India, and is believed to be due to malarial agency. The obstruction to the lymph-vessels is supposed to be the result of a precedent inflammation of the inguinal glands, the infiltration of which, by compressing the afferent lymphatics coming from the generative organs as they enter these bodies, prevents the entrance of the lymph, in consequence of which it is dammed back. This explanation, however, is hardly satisfactory, since we constantly observe inflammatory enlargements of the inguinal glands without any such results.

Rindfleisch,* in speaking of these hypertrophies of the scrotum and penis

* Pathological Histology, p. 313.

and mons veneris, and which he terms *pachydermia lymphangiectatica*, attaches much importance to the rôle played in cases of elephantiasis by the organic muscular fibres of the corium, which he alleges are the subject of a special hyperplasia and neoplasia, and which, by their contraction, so constrict those perpendicular vessels which establish a communication between the superficial and deep net-work of lymphatics, as to cause a stagnation in the former, and thus produce the characteristic swelling and lymph vesication. On this theory, the lymph swelling of the scrotum would be simply lymphatic congestion of and transudation through the subcutaneous lymph-vessels. But we cannot stop here, as in some instances at least there also exists a hypertrophy of the connective tissue, the reality of which has been shown by the excisions which have been practiced for the removal of scrotal tumors of this nature.

The treatment for lymph scrotum is quinine, iodine, and change of climate. Where, along with the lymph swelling, there exists increasing hypertrophy of the connective tissue, excision will be required.

Epithelioma of the Scrotum, commonly known as the "chimney-sweep's cancer," or "soot cancer," has almost entirely disappeared since the introduction of coal for the purpose of heating dwellings. The disease generally begins as a wart-like body, situated at the most dependent part of the scrotum. In most instances a single wart is present, though sometimes there may be several. These excrescences, after a time, soften, their surfaces becoming inflamed, abraded, and covered with incrustations which are detached later; the callous surface of the wart finally softens, ulcerates, and terminates in an open sore, superficial in depth, with hard, irregular, everted, sometimes inverted, and undermined edges, and furnishing a thin, ichorous discharge. (Fig. 1314.) As the disease advances, the ulcer enlarges in both circumference and depth, until the entire scrotum and the tunica vaginalis are destroyed. The disease seems to have little tendency to attack the testicle. Its ravages are not confined to the scrotum alone, but may extend to the perineum, the penis, and the mons veneris.

The inguinal glands do not participate in the disease at an early period, but finally become enlarged, indurated, and painful. They suppurate, open, and discharge an offensive blood-stained fluid, having, like that from the sores of the scrotum, an offensive odor, and leaving deep ulcers, which continue to enlarge in every direction. The general system in time sympathizes with the local disorder; the appetite fails, the patient loses flesh, passes sleepless nights, is harassed with darting pains, and begins to present that peculiar sallow or waxy color of the face which reveals the nature of the cachexia, until, finally, worn out by continued suffering, death comes to his relief.

As has been stated, epithelioma of the scrotum is commonly a disease of

FIG. 1313.



Lymph scrotum.—From Carter.

FIG. 1314.



Epithelial cancer of the scrotum.

chimney-sweeps, and is caused by the soot lodging in the depressions between the corrugations of the integument, where it slowly acts as an irritant. But there is doubtless more required for the production of the affection than occupation, as comparatively few chimney-sweeps are attacked, and in some the warts remain as harmless excrescences. There is probably, as in epithelial carcinoma elsewhere, some predisposing constitutional condition which underlies the local lesion, and on which depends its benign or malignant course.

The operation of the irritant is exceedingly slow, as it is rarely, if ever, met with in boys, by whom this work is done; adults between thirty and forty being the persons who generally suffer.

I have never seen a case of the disease in Philadelphia or elsewhere in this country. It is said to be unknown in France, and rarely witnessed in Germany. The comparative prevalence of the affection in Great Britain at one time was probably due to the quality of coal used as fuel.

Soot, when applied to other parts of the body than the scrotum, is capable of producing a sore. Gardeners, who sometimes use this material for the destruction of insects which infest the leaves of certain plants, have suffered from irritable sores on the hands. Dr. Paris has seen cases of scrotal epithelioma occur in smelters.

Epithelioma of the scrotum is generally very slow in its progress, seldom proving fatal sooner than from six to eight years, and in some instances after a much longer period.

TREATMENT.—Early excision is the proper remedy, including in the operation the sound tissue of the scrotum some distance beyond the visible limits of the disease. The vessels must be all carefully tied, and the wound closed with interrupted or twisted sutures. If the operation is undertaken early, there will be a reasonable probability that the disease will not return. When the glands of the groin are implicated in the disease, they should also be removed.

When the disease is too far advanced for the knife, the only resource is to palliate, by the administration of opiates to relieve pain, by cleansing the parts frequently, and by the employment of mild unirritating dressings.

Medullary and melanotic carcinoma rarely occur in the scrotum primarily. Two cases of the latter disease have been recorded by Curling, one seen by himself and the other recorded by Ronge, of Lausanne, Switzerland.

Cystitis.

Cystitis, in the general acceptance of the term, means inflammation of the mucous membrane of the bladder. The other tunics of the viscus are not exempt from inflammatory attacks; but when they suffer, it is not usually a primary condition, but an extension of the disease, either from the peritoneum or the mucous side of the organ. Thus, we have pericystitis, or inflammation of the cellular tissue connecting the peritoneum and the bladder; vesical peritonitis, or epicystitis; and interstitial cystitis. When cystitis occurs, all the coats of the organ are affected, both in the *acute* and in the *chronic* form.

Acute cystitis is not a very common affection; it may arise from traumatic causes, from an extension of inflammation from neighboring parts, and from the poisonous effects of certain drugs.

Among those forms of the disease having a traumatic origin are such as arise from lithotomy, lithotrity, catheterism, and foreign bodies in the bladder, as stone, or substances which enter the viscus designedly through the urethra or accidentally through the walls of the abdomen or the pelvis. Among the foreign substances the depositions from decomposed urine may also be included. When developed by an extension of disease from adjacent parts, it is in consequence of a pre-existing gonorrhœa, a prostatitis, or an inflamed stricture.

The drugs which have a tendency to affect injuriously the mucous membrane of the bladder are cantharides and oil of turpentine, which operate physiologically through the general system, and caustics, as nitrate of silver

and the mercurial acids, which are sometimes employed as injections, and which operate chemically.

Cystitis is more common in men than in women.

SYMPTOMS.—The symptoms of cystitis in its commencement differ somewhat according to the determining cause. When traumatic, it may be announced by chills followed by febrile excitement. In other instances, and when from other causes, it is ushered in by a feeling of uneasiness, which is located deep in the perineum, about the neck of the bladder, accompanied by frequent calls to urinate, attended with pain and vesical tenesmus, and a scalding sensation experienced along the whole extent of the urethra. The bladder becomes exceedingly intolerant of the pressure of the urine, which is expelled in small quantities, but without affording any feeling of relief. Tenderness and fullness are experienced in the hypogastrium and the perineum, and from these regions darting pains frequently extend along the urethra to the testicles, to the lumbar and sacral region, and down the inner sides of the thighs. The urine soon undergoes changes in quantity, appearance, and quality. It becomes scanty, alkaline, and at first high-colored, then reddish and cloudy, containing blood, and finally ropy, thick, turbid, muddy, purulent, containing much vesical epithelium, and heavily charged with urates and amorphous phosphates.

The extreme irritability of the neck of the bladder is often such that, after a few drops of urine escape, it becomes spasmodically closed, so that the organ is not relieved of its contents, which gradually accumulate, until it forms a distinct tumor above the pubes.

The constitutional disturbance, when the disease is of a grave form, is very marked, as indicated by a frequent and resisting pulse, thirst, headache, and nausea, with great restlessness and mental anxiety.

When the cystitis arises from an extension of gonorrhœal inflammation, the disease is confined chiefly to the neck of the bladder, and the local symptoms of weight, fullness, tenesmus, and constant micturition are even more incessant and distressing than when the disease arises from traumatic causes; but, though there may be even greater mental disquietude, there is a singular freedom from signs of febrility.

When cystitis progresses towards a fatal termination, portions of the walls of the bladder may suppurate or even slough, and be discharged in stringy fragments; the urine emits a horrid odor, from the products of its own decomposition and the gases resulting from the dead mucous and submucous tissue which it contains; the patient is harassed with hiccough; the pulse becomes very frequent and small, the tongue dry and hard, streaked with a dark coat; the strength rapidly fails; the secretion of the kidneys diminishes or is entirely suspended; the countenance becomes sunken and cadaverous, the extremities cold, the surface moistened with perspiration, from which emanates the odor of urine, and the patient at last passes into a state of profound stupor, from which he never awakes.

The course of acute cystitis is ordinarily very rapid, rarely extending beyond eight or ten days, when, should it not terminate in resolution, the disease gradually passes into the chronic form.

Acute cystitis at the neck of the bladder may be confounded with acute prostatitis; but there are certain marked differences between the two diseases which, when contrasted, will enable the practitioner to reach a positive diagnosis.*

CYSTITIS.

Much pain experienced in passing the last drops of water in urination.
Tenesmus constant and urgent.
The discharge of a thick, turbid, ropy fluid at the termination of the micturition.
Retention of urine not common.
Prostate body normal.

PROSTATITIS.

Comparatively little pain.
Neither constant nor severe.
Urine little changed.
Retention common.
Enlarged, which can be ascertained by digital examination through the rectum.

* For additional differential symptoms, see page 495.

PATHOLOGY.—The changes which are produced by acute cystitis consist in increased vascularity of the mucous membrane, its light-red color being exchanged for one of a scarlet hue, more strongly marked at some portions of its surface than at others. In consequence of the over-strained vessels giving way at certain points, patches of ecchymosis may be also seen. The inflammatory redness often exists in spots, imparting a mottled appearance to the mucous membrane. These circumscribed districts of color are found to consist of zones of vascularity around the glands which lie imbedded in the submucous connective tissue and which have participated in the general inflammation. In addition to these structural alterations, the membrane is swollen, softened, and sometimes ulcerated at points. Nor are the inflammatory changes always limited to the mucous and submucous tunic and perimysium. They may involve all the coats, and even extend to the vesico-peritoneal cellular tissue, occasioning by the resulting interstitial infiltration marked thickening or suppuration in and about the walls of the bladder, together with peritonitis. As in the mucous membrane of the fauces and larynx and trachea in inflammatory diseases, so in that of the bladder there may be foreign deposits and fibrinous membranes, fragments or shreds of which are sometimes discovered in the urine.

TREATMENT.—Acute cystitis demands prompt treatment. The patient must be placed in bed with the hips elevated; blood should be taken from the perineum by leeches; the bowels must be kept open, but not actively purged; hot hip-baths for twenty minutes are to be twice or thrice repeated during the twenty-four hours, followed by flaxseed-meal poultices to the perineum and over the hypogastric region as warm as can be borne. The patient must also be allowed the free use of alkaline diluent drinks, as flaxseed or slippery-elm tea containing a little bicarbonate or citrate of potash.

The vesical irritability will be best allayed by suppositories of opium with the extract of hyoscyamus. The diet must consist for the first three or four days exclusively of milk. In the event of retention taking place and not being relieved by the hip-bath and an anodyne enema, it will be necessary to draw the urine with a soft catheter; but under no circumstances is the instrument to be allowed to remain, as it would add to the severity of the local inflammation.

When the cystitis has been produced by the presence of a foreign body in the bladder, the treatment will not materially differ from that detailed. But no operation should be attempted for the removal of such body during the acute stage of the attack.

When local congestion, or that irritation of the neck of the bladder called stranguary, is developed by the specific action of cantharides (either from the absorption of cantharidin through a blistered surface or from the internal employment of the drug) or by the action of a terebinthinate, the use of the drug must be suspended at once, an enema administered consisting of two tablespoonfuls of starch-water and forty drops of laudanum for an adult, and diluent drinks freely given.

Chronic Cystitis, Vesical Catarrh, or Cystorrhœa.—This is the most common and the most intractable of all affections of the bladder. It is invariably the result of some pre-existing disorder of the urinary passages, and in a large number of cases is beyond the reach of any remedial measures whatever. It is not peculiar to any time of life, though commonly met with in persons beyond the middle period, males being more frequently the subjects of the disease than females.

CAUSES.—The causes of chronic cystitis are such as interfere with the complete evacuation of the contents of the bladder, and are consequently obstructive, as the existence of sacculi, stricture, gleet, hypertrophy of the prostate, paralysis of the bladder, and morbid growths within the viscus.

Among mechanical causes may be mentioned stone, the frequent use of instruments, and the muscular weakness which results from over-distention of

the organ. Associated with this dilatation is a form of vascular paralysis resulting from the sudden removal of pressure, which leaves the vessels in a helpless and congested condition favorable to inflammatory accidents.

The foundation for chronic cystitis is often laid by too long retention of the urine, and it may originate from the same cause in persons who, in consequence of extreme weakness of body and the mental hebetude which attends protracted attacks of illness, are not keenly conscious of the sensations of their internal organs,—a fact which suggests the necessity for the physician's being always aware of the possibility of such complications and interfering for their prompt removal. Alterations in the urine which may occur even before it has reached the bladder, as when it results from disease of the kidneys, though among the less common causes of the disease, are influential in producing chronic inflammation.

SYMPTOMS.—Chronic inflammation exists in different degrees of severity. It may be characterized only by a frequent desire to micturate and a cloudy appearance of the urine, due to the presence of mucus and a small amount of pus.

In the more pronounced form of the disease the calls to urinate become more frequent, only a small quantity of water being passed at each act. Considerable smarting and pain are felt along the course of the urethra, and an unsatisfied feeling, as though the bladder had not been completely emptied, with a sense of uneasiness and fullness in the hypogastric region. The urine undergoes very important and characteristic alterations. At first turbid and containing mucus and pus in abundance, it deposits, after standing a short time, a thick, tenacious, ropy, or stringy muco-purulent substance, which, when the supernatant fluid is poured off, may be turned out into another vessel as a semi-transparent, gelatinous mass, resembling a concentrated infusion of linseed tea. The chemical constitution of the urine is also altered, the secretion becoming alkaline, ammoniacal, and mixed with the inflammatory products of the mucous membrane, as mucus, pus, vesical epithelium, and phosphates.

PROGNOSIS.—The prognosis in vesical catarrh will depend on the ability of the surgeon to remove the cause, and on the duration of the disease. If arising from the presence of a calculus, and the patient is not in advanced life, there will be a strong probability that on the removal of the stone the disease will disappear. If, however, it is the sequel of an old stricture, of a sacculated or paralyzed bladder, or of a hypertrophied prostate, the patient should be made to understand that nothing beyond palliation is possible.

TREATMENT.—In assuming the care of a case of chronic cystitis, the first inquiry should be as to its cause. If it is occasioned by stricture, the obstruction must be removed as far as possible by the plan of treatment best adapted to the particular case; if it arises from stone in the bladder, the calculus must be removed.

Rarely will it be necessary to employ local bleeding, unless an acute element has been engrafted on the chronic, when the abstraction of blood from the perineum by leeches will exert a salutary effect. The urine must be examined from time to time by the usual test with litmus-paper, so as to maintain the secretion as nearly as possible in a *neutral* state. This will be done by the administration of alkaline remedies, as the bicarbonate of soda or of potash, or liquor potassæ, when it is acid, and by the use of acids, as nitric or nitro-muriatic acid, when it is alkaline.

When there is reason to believe that a portion of the urinary secretion is retained, as must often happen in hypertrophy of the prostate, in a sacculated condition of the bladder, or in atony or paralysis of its walls, the soft catheter should be used as often as the viscus will allow without adding to its irritability, twice in twenty-four hours not being too frequent.

If the patient is obliged to rise frequently at night, and is unable to obtain a sufficient amount of rest, a suppository of opium may be introduced at bedtime into the bowel.

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The foundation for chronic cystitis is often laid by too long retention of the urine, and it may originate from the same cause in persons who, in consequence of extreme weakness of body and the mental hebetude which attends protracted attacks of illness, are not keenly conscious of the sensations of their internal organs,—a fact which suggests the necessity for the physician's being always aware of the possibility of such complications and interfering for their prompt removal. Alterations in the urine which may occur even before it has reached the bladder, as when it results from disease of the kidneys, though among the less common causes of the disease, are influential in producing chronic inflammation.

SYMPTOMS.—Chronic inflammation exists in different degrees of severity. It may be characterized only by a frequent desire to micturate and a cloudy appearance of the urine, due to the presence of mucus and a small amount of pus.

In the more pronounced form of the disease the calls to urinate become more frequent, only a small quantity of water being passed at each act. Considerable smarting and pain are felt along the course of the urethra, and an unsatisfied feeling, as though the bladder had not been completely emptied, with a sense of uneasiness and fullness in the hypogastric region. The urine undergoes very important and characteristic alterations. At first turbid and containing mucus and pus in abundance, it deposits, after standing a short time, a thick, tenacious, ropy, or stringy muco-purulent substance, which, when the supernatant fluid is poured off, may be turned out into another vessel as a semi-transparent, gelatinous mass, resembling a concentrated infusion of linseed tea. The chemical constitution of the urine is also altered, the secretion becoming alkaline, ammoniacal, and mixed with the inflammatory products of the mucous membrane, as mucus, pus, vesical epithelium, and phosphates.

PROGNOSIS.—The prognosis in vesical catarrh will depend on the ability of the surgeon to remove the cause, and on the duration of the disease. If arising from the presence of a calculus, and the patient is not in advanced life, there will be a strong probability that on the removal of the stone the disease will disappear. If, however, it is the sequel of an old stricture, of a sacculated or paralyzed bladder, or of a hypertrophied prostate, the patient should be made to understand that nothing beyond palliation is possible.

TREATMENT.—In assuming the care of a case of chronic cystitis, the first inquiry should be as to its cause. If it is occasioned by stricture, the obstruction must be removed as far as possible by the plan of treatment best adapted to the particular case; if it arises from stone in the bladder, the calculus must be removed.

Rarely will it be necessary to employ local bleeding, unless an acute element has been engrafted on the chronic, when the abstraction of blood from the perineum by leeches will exert a salutary effect. The urine must be examined from time to time by the usual test with litmus-paper, so as to maintain the secretion as nearly as possible in a *neutral* state. This will be done by the administration of alkaline remedies, as the bicarbonate of soda or of potash, or liquor potassæ, when it is acid, and by the use of acids, as nitric or nitro-muriatic acid, when it is alkaline.

When there is reason to believe that a portion of the urinary secretion is retained, as must often happen in hypertrophy of the prostate, in a sacculated condition of the bladder, or in atony or paralysis of its walls, the soft catheter should be used as often as the viscus will allow without adding to its irritability, twice in twenty-four hours not being too frequent.

If the patient is obliged to rise frequently at night, and is unable to obtain a sufficient amount of rest, a suppository of opium may be introduced at bedtime into the bowel.

A vast number of internal remedies are recommended in cases of vesical catarrh. Many of these are utterly devoid of virtue, while others may be administered with benefit. Those which are entitled to most confidence are capsules of tar, tar-water, balsam of copaiba, the terebinthinates, triticum repens in decoction (℥iii in one quart of water, boiled down to one pint, and drunk during the day), uva ursi, benzoic acid (grs. ii three times a day), fluid extract of pichi, and, not the least important, plain water used freely.

From these remedies one should be selected, and if it fails to afford any relief it can be exchanged for another, until the one best suited to the case is discovered. I have sometimes derived great benefit from a mixture consisting of the decoction of uva ursi, liquor potassæ, and the juice of belladonna leaves, prepared according to the following formula:

R Decoct. Uvæ Ursi, ℥viii;
Liquor. Potassæ, gtt. cxxx;
Succi Belladonnæ, gtt. xlviij.
Sig.—Tablespoonful every four or five hours.

Harlem oil has enjoyed considerable popularity as a remedy in chronic inflammatory affections of the bladder, and in some instances may be given with decided advantage.

The introduction of liquids, plain or medicated, into the bladder, as washings, is of great value. At one time I was disposed to believe that this practice was of little benefit, but a more enlarged experience has led me to abandon this opinion. I have accomplished much good by the use of the following vesical injections: water which has been previously boiled; boracic acid grs. vi, water ℥i; permanganate of potash gr. i, water ℥i; carbolic acid gtt. iii-iv, water ℥i; biborate of soda grs. iii, water ℥i. Very seldom is it necessary to use more than three or four ounces of these liquids, the procedure being repeated every day or two until the organ is entirely cleared of deposits.

Not unfrequently crusts composed of phosphates become adherent to the mucous surface of the bladder, or particles of the same matter form within the cavity of the organ, giving rise to much local and general irritation. Under these circumstances a chemical solvent, like the acetate of lead (grs. ii, water ℥i), should be used as a vesical wash. When the gum-bag with stop-cock and nozzle is not at hand, an ordinary hard rubber syringe with its nozzle fitted to the end of a soft rubber catheter will answer.

From irrigation I was disposed at one time to hope that some good might be obtained by judicious management, and bestowed the greatest possible attention upon all the details of the process, having a reservoir constructed, which could be kept at any desired elevation, so as to regulate the pressure of the fluids, and which was supplied with a lamp and a thermometer, in order to preserve the liquid at a proper temperature. This receptacle was placed in connection with a double catheter introduced into the bladder, and a constant stream allowed to flow through that organ. The liquid used was medicated by different articles, as carbolic acid, permanganate of potash, biborate of soda, etc. It was not possible, however, to continue the irrigation beyond thirty-six hours, as it occasioned so much vesical distress as to demand its suspension.

The operation can be readily done by a gum or metallic catheter, with a gum bag for containing the liquid, the nozzle of which is to be inserted into the end of the instrument. (Fig. 1315.)

In charging the bag with the liquid, the stop-cock is to be opened and the air pressed out of the bag while its nozzle is placed beneath the fluid; it is then gradually released from the compression of the hand, when the water will be drawn up. Before putting the nozzle into the catheter, the bag should be pressed until the fluid appears at its extremity, and the injection should cease before it is entirely exhausted. In this way the entrance of air into the bladder can be avoided.

The washing may also be accomplished by gravity, the fluid being poured into the gum funnel, which is connected with the catheter by a flexible tube, all air having been displaced before opening the communication between the two. (Fig. 1316.)

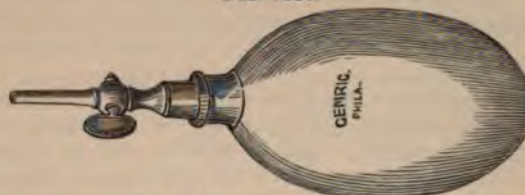
Heroic injections of the nitrate of silver (forty grains to the ounce) have been employed, and even the application of the solid stick to the mucous surface has been practiced, especially to that portion at the neck of the bladder. Such solutions are to be deprecated, and when nitrate of silver is used, one-fourth to one-half grain to the ounce of distilled water is sufficiently strong.

Vesical suppositories of morphine have been employed to some extent by Mr. Harrison, of Liverpool, with a view to allay the irritability of the organ, and apparently with very good effect. The salt is fashioned into the proper form by mixing it with cacao butter and pressing it into a little mould. It is then introduced into a canula of the shape of a catheter, armed with a stylet. (Fig. 1317.) When the point of the instrument reaches the neck of the bladder, the stylet is pushed forward, which drops the suppository into the viscus.

Opening the neck of the bladder has been practiced in some instances for the cure of intractable cases of vesical catarrh. The design of this procedure is to drain the urine out of the bladder as soon as it is discharged from the ureter, and in this way remove one of the principal causes of the perpetuation of the disease.

Of 36 cases of cystotomy in the male performed for cystitis, and collected by Dr. Weir, of New York, who has very kindly furnished to me the results of his analysis, 11 died either in consequence of causes directly traceable to the operation, or from renal complications; 17 were pronounced cured,

FIG. 1315.



Gum bag for injection of the bladder.

FIG. 1316.



Apparatus for washing out the bladder by gravity.

FIG. 1317.



Mr. Harrison's instrument for conveying suppositories into the bladder.

or so much relieved as to approach a cure; 4 were only slightly relieved; and 4 failed entirely.

In 20 of the 36 cases lateral cystotomy was performed; in 4, bilateral; in 5, median; and in 7 the form of the operation was not stated.

In 2 of the recovered cases in which lateral cystotomy was done, the median portion of the prostate was also removed; and to this fact was the cure ascribed.

In the 5 median sections the prostate was only dilated, and in 2 the gland was, in addition to dilatation, incised to some extent.

In 5 median sections of my own with drainage for six weeks, 2 seemed to have been cured, 1 was greatly relieved, 1 temporarily benefited, and 1 unimproved. When uncontrollable vesical spasm is present in cystitis, perineal or supra-pubic cystotomy with drainage should not be withheld.

The most that can be said is that the operation is on trial. Statistics thus far do not present a very flattering prospect. Contemplating the subject from an anatomical and physiological point of view, I am not sanguine as to permanently good results.

The diet, exercise, and habits of a patient suffering from vesical catarrh must be carefully regulated. Stimulating or highly-seasoned food must be avoided, milk, animal broths, eggs, and farinaceous articles being most suitable for use. Many persons derive considerable relief from the free use of onions, and also from water-cresses. Wines, brandy, whisky, gin, and stimulants generally are contra-indicated. Old cider, if perfectly sound and not too acid, may sometimes be drunk with advantage. The innumerable waters whose powers over these affections are so highly extolled possess little superiority over good water. Two of the natural waters, however, Rockbridge Alum and Capon, enjoy deservedly a good reputation as palliative diuretics. I have employed the first, with good results. The body must be well protected against the changes of weather by wearing woolen underclothing during winter and spring, and the feet should be kept warm and dry. Warm bathing, by keeping the cutaneous glands active, will conduce to the patient's comfort. Riding on horseback or in rough conveyances, standing long on the feet, heavy lifting, and sexual excesses must be avoided.

The results of inflammatory diseases of the bladder are suppuration, abscess, ulceration, gangrene, hypertrophy, contraction, and vesical nervousness or irritability.

Suppuration, except as the result of chronic cystitis, is rarely witnessed. In malignant growths of the organ purulent matter may be discharged with the urine, but it is either the product of a local cystitis, or is derived from the granulations of the carcinomatous disease.

Abscess of the bladder is extremely uncommon. It has occurred in the walls of the organ, either on account of a pre-existing chronic cystitis or from injury. It may be circumscribed or diffuse, and in either event is an exceedingly grave condition. The existence of abscess cannot be determined by any means at our command, and, consequently, its diagnosis must be a matter of mere conjecture.

Ulceration is also very unusual, though occasionally met with as the effect of long-continued inflammation of the bladder, or of tuberculous or malignant disease of the viscus. It may also follow the pinch of a lithotrite or the continuous contact of a catheter.

The signs of ulceration are severe pain, which is referred to a very limited region of the bladder, the micturitic paroxysm, due to spasm of the muscular fasciculi underlying the ulcer, and discharge of blood mingled with vesical epithelium and dark fragments or shreds of the mucous membrane. The calls to make water increase as the disease progresses, and the suffering greatly exceeds that of ordinary cystitis. The general exhaustion is rapid and extreme, and the progress of the disease is to a fatal termination. The ulcer presents a round or oval outline; its edges are infiltrated, sometimes elevated and at other times depressed. The ulceration is liable, especially in the female, to destroy all the coats of the bladder.

The disease has so many features in common with acute cystitis that its diagnosis in the male is a matter of much uncertainty. The most characteristic differential sign is the presence in the urine of fragmentary shreds of the mucous and submucous tissue from the ulcer, which are not met with in acute or chronic cystitis. The disease is more easily recognized in the female than in the male, as in the former the exploration of the bladder can be made with the finger.

TREATMENT.—As remedies either administered through the general system or addressed directly to the interior of the bladder do little more than assuage pain, it has been proposed by Mr. Guthrie to open the neck of the bladder and in this way put at rest its muscular walls, the movements of which prevent the cicatrization of the ulcer. The suggestion has been carried into effect by Dr. Willard Parker, by Sir James Y. Simpson, and by Drs. Bozeman, Emmet, Parvin, and others, with the most encouraging success. The patients thus treated were all females. But there is no reason, if the diagnosis can be established with a moderate degree of certainty, why a similar procedure may not be followed by good results in the male.

Gangrene of the bladder rarely occurs. It has been observed as the effect of intense cystitis, extreme distention of the organ, and malignant disease. Isolated patches of gangrene at the neck or the *bas-fond* of the viscus sometimes follow both lithotomy and lithotrity. A similar localized form of this disease has been known to appear during an attack of typhoid fever. If in the course of acute cystitis there should occur a sudden cessation of pain, great prostration, a very feeble pulse, with a cold, perspiring skin, sunken features, stupor, and hiccough, the existence of gangrene would be highly probable. Should gangrene be induced by excessive distention of the bladder, a rupture of the softened coats may take place, either during fruitless efforts to urinate, or from ulceration, and the urine escape into the abdomen, causing a fatal peritonitis. The sudden subsidence of the vesical tumor, and the existence of intense pain, with a distended and tender abdomen and collapse, would sufficiently declare what had happened. Little can be done in the way of treatment after such an accident. Opium will be required to alleviate suffering, stimulants to counteract the extreme exhaustion, and, if there is evidence of urinary extravasation into the cellular tissue of the pelvis, an opening should be made through the perineum.

Hypertrophy is a symptomatic and never an idiopathic condition, but is induced by any cause which persistently teases the muscular wall into contraction. Thus, all inflammatory states of the mucous membrane of the bladder, as acute and chronic cystitis, particularly the latter, and all obstructive causes, as hypertrophy of the prostate and stricture, which interfere with the free escape of the urine, by provoking, through reflex irritation, the frequent and vigorous contraction of the detrusor muscle, increase the nutrition of its fibres until they attain many times their natural bulk. The fasciculi project on the inner surface of the bladder, so as to give to it a ribbed or columnar appearance, strongly resembling the columnæ carneæ of the ventricles of the heart, which condition can be recognized with great distinctness with the point of a catheter or sound when carried into the bladder. (See Fig. 1275.)

This muscular hypertrophy may be eccentric or concentric. In the first form the thickening is attended with general dilatation of the organ, and has been induced by obstructive causes; while in the latter form no internal resistance whatever has been encountered, the urine being expelled almost as soon as it enters the viscus; this is the common attendant of cystitis. This latter condition is sometimes designated *contracted bladder*. One of the evils connected with the eccentric hypertrophy is the formation of pouches, which are simply herniæ of the mucous and cellular coats of the bladder protruding between the adjoining muscular fasciculi. These sacs form diverticula for the urine, in which decomposition occurs.

Being merely an effect of disease, no treatment can avail for the arrest of hypertrophy except such as is calculated to remove the primary or determining condition on which its existence depends.

Atrophy of the bladder is much more common than is generally supposed. There is in atrophy not a wasted condition of any single coat of the viscus, but all are diminished in thickness and preternaturally soft and unresisting.

The bladders which I have examined in the dissecting-room and the walls of which were preternaturally thin belonged generally to aged persons who were thin and emaciated. In paralysis it is likely to occur from defective nutrition; and so also in cases where the organ has been over-distended this atrophy is the result of a fatty metamorphosis. Hunter and Bonnet have recorded cases of rupture of the bladder, even in young subjects, by the simple pressure which was made over the abdominal walls during catheterization.

In addition to the results of vesical inflammation which have been described, there are others which affect the associate organs. The kidneys rarely escape becoming diseased in old cases of vesical catarrh. Thus, we often have pyelitis, nephritis, abscesses, and Bright's disease, from the effects of which the fatal termination is hastened.

Vesical Neurosis.

Under this head I would include those disturbances of function and sensibility which frequently affect the bladder, which appear to be entirely independent of any co-existing inflammatory element, and which characterize the affection described as irritable bladder and neuralgia of the bladder.

This condition may be idiopathic or secondary to previous disease of the organ. The characteristic symptom is frequent urination, the patient being obliged to obey the call to pass water immediately on feeling the desire, which may return every half-hour or hour. Micturition is usually accompanied with pain, sometimes very severe, spasmodic, and burning in its character, which is referred to the neck of the bladder, and is not entirely relieved by urination. The urine may be perfectly clear, exhibiting no visible signs of any change in its constitution, though generally there is an unusual amount of phosphates and urates present. Neither may it be materially diminished or increased from the normal amount. In other instances, when the disease has lasted for some time, the secretion is highly acid, containing a considerable amount of mucous matter, which will be quite noticeable after the water has been allowed to stand for some time. A dull feeling of weight is often experienced in the perineum and rectum. Usually the individual, if once asleep, is not disturbed during the night; and even in the daytime, when the mind is earnestly occupied either in business or in amusement, the harassing desire to urinate may be absent. The erections are sometimes frequent and annoying, and at other times cannot be produced by the most vigorous effort of the imagination. In this latter state of the sexual organs it is not unusual to find in the urine an abundant supply of crystals of oxalate of lime. In addition to the functional disturbance of the digestive organs, indicated by loss of appetite, flatulence, and constipation, the mental disquietude which accompanies the affection is generally very marked. The individual loses interest in his business, has little disposition for exertion of any kind, and is greatly depressed in spirits. In other cases the dominant symptom, next to frequent micturition, is severe paroxysmal pain, which, though centred at the neck of the bladder, radiates in the direction of the testes, anus, perineum, thighs, and loins. There is also a burning sensation along the urethra. The urine may be projected violently in spurts, or it may be discharged in a slow and feeble stream. An attack of this nature will sometimes continue for several days, or it may terminate in a few hours, leaving a feeling of soreness or tenderness in the perineum, less frequently above the pubes. Passing an instrument into the bladder after an attack of this nature, the

prostatic part of the urethra will be also found to be in a supersensitive state.

A third variety of this affection is a sequel of acute cystitis or prostatitis, in which, although all inflammatory phenomena have disappeared, the bladder is left in an irritable state, indisposed to retain more than a few ounces of urine at a time, and which probably will be found to contain a little mucus. The uneasiness experienced when an attempt is made to resist the inclination to micturate does not amount to pain, and after the water has been passed the relief is complete for a time.

Vesical neurosis is not confined to males: females frequently suffer in the same way. The attacks are sometimes sudden, without any premonition, though oftener their approach is announced by a precedent uneasiness about the perineum.

Young persons and those of mature life, both married and single, the continent and the incontinent, are alike liable to this affection.

CAUSES.—In the idiopathic variety, these may be gout, rheumatism, calculus, and miasma; but by far the most fruitful sources of the trouble are masturbation and the sudden interruption of venereal excesses. I have seen characteristic examples of this disorder in syphilitic patients. Acid fruits will also sometimes develop an attack. The peculiar organization of the prostatic part of the urethra rendering this portion of the canal a chief factor in that series of acts which culminates in the completion of full coitus, together with its rich supply of nerves and the fact that this affection is closely associated with disturbances of the sexual functions, would seem to indicate that the primary seat of vesical neurosis is located about the prostate. When following in the wake of a primary cystitis, there is probably some vascular congestion concerned in keeping up the irritability.

TREATMENT.—A close inquiry should always be instituted, with a view to discover any tangible causes to which the disease might be ascribed. These inquiries will embrace the probability of stone in the bladder, which will be settled by the sound, the secret practice of masturbation, the social state of the patient, whether single, married, or a widower, antecedent history as to arthritic or gouty tendency, the composition of the urine, with any other interrogation which may tend to reflect light on the case. Everything, therefore, depends on the removal of the cause. If a calculus exists, its extraction, either by cutting or by crushing, will become necessary. If sexual excess or extreme continence has been instrumental in causing the attack, moderation or abstinence must be enjoined in the one case and marriage in the other.

When the vesical trouble is associated with pain, swelling, and redness of a joint, its gouty or rheumatic origin may be confidently assumed, and relief will be obtained by a mercurial purge, followed by the exhibition of full doses of the iodide of potassium, with the wine of the root of colchicum.

Miasmatic causes are to be inferred when the attack comes on at definite periods, and when there has been a previous exposure in unhealthy localities: in these cases quinine and arsenic are the remedies which promise relief.

When there has been a history of constitutional syphilis, full doses of the iodide of potassium will be found to act like a charm. One of the severest cases of this affection which I have ever witnessed, and which had baffled all previous treatment, was promptly cured by twelve-grain doses of this salt.

When an examination reveals the presence of oxalate of lime in the urine, it will be necessary to regulate the diet, and, in order to correct the vice, to administer nitro-muriatic acid.

In young females this functional disturbance is often associated with irregularities of the menses, which will be best corrected by a course of iron, quinine, and strychnine. During the severity of an attack the pain must be relieved by suppositories of opium and extract of belladonna, or by an enema of laudanum and the use of the hot hip-bath. When the irritability of the bladder has succeeded to an attack of cystitis, there must be enforced the

strictest attention to diet, directing chiefly milk and farinaceous preparations of food and the avoidance of alcoholic beverages, of horseback-riding and of venereal excesses. The cold hip-bath will constitute an important adjuvant to the treatment.

After the most rigid search into every possible cause which may be concerned in vesical irritability, there will still remain a certain number of cases the causes of which will elude the most critical research; and though doubtless there is a physical basis for the disturbance, yet its chief importance has grown out of habit or from psychological peculiarities. I have been able in such cases to effect complete and permanent cures by instructing the patient to commence a work of bladder education; that is, not to yield to the first desire to urinate, but to resist the inclination, and thus prolong the period between the micturitions, seven or eight minutes at each time, until the mastery over the rebellious organ has been obtained.

Recto-Vesical Fistula.

A fistulous opening between the bladder and the rectum may originate in various ways,—sometimes as an effect of chronic inflammation, more commonly from a wound being inflicted on the bowel during that stage in the operation of lithotomy when the prostate is being divided.

A calculus may cause ulceration in the vesico-rectal walls and terminate in a fistula. The same result has followed tapping the bladder through the rectum. A sharp-pointed foreign body may become arrested in the rectum and ulcerate forward into the bladder. I removed a calculus from the bladder of a patient which contained as a nucleus quite a large raisin. He had been suffering for three years with a recto-vesical fistula, caused by a chicken-bone, which, in passing along the bowel, had become arrested, and finally entered the bladder by ulceration. The bone, which was one inch and a half long, was discharged through the urethra several months before the operation of lithotomy. Cancer of the rectum, in the progress of its destructive ulceration, not unfrequently destroys the walls of the bladder and forms a fistulous opening between the latter and the bowel. A similar opening may be caused in the female as the result of pelvic cellulitis.

The signs of recto-vesical fistula are usually very obvious, air and feces passing into the bladder and escaping through the urethra, and urine entering the rectum.

TREATMENT.—When the fistula is located some distance up the bowel and communicates with the *bas-fond* of the bladder, it will often defy all plans of treatment. When lower down, at the neck of the bladder, or in the prostate body, a cure may sometimes be accomplished. The means usually employed for the purpose are caustic, the actual cautery, and closure by sutures.

The caustics which procure the best results are the acid nitrate of mercury and nitric acid, either of which can be most conveniently applied to the abnormal opening by the use of a silver probe somewhat bent at the extremity, or by a small glass rod. The instrument for using the caustic should pass into the fistula, and not be merely brought in contact with its external orifice. Before using the caustic it is necessary to have the bowel thoroughly cleared out. The patient should be placed on the knees and elbows, with the pelvis well raised, in which position the fistula can be best exposed by introducing into the rectum a duck-bill speculum. After the cauterization the bowels must be kept quiet for seven or eight days by the use of opium, after which they can be opened and a second application made of the caustic. If, after four or five repetitions of this agent, no progress is made towards a cure, this method of treatment should be abandoned for the cautery, the most eligible apparatus for the purpose being that of Paquelin. The galvano-cautery will also answer very well. In the absence of either, a fine olive-pointed hot iron will fulfill the object in view. The application

should be made through a cylindrical speculum having an oblong fenestra in its walls.

When the fistula is low down and can be readily exposed by means of the duck-bill speculum, it will be better to proceed at once to pare the edges of the opening and bring the sides together with silver sutures, securing the latter by the shot clamp. During the treatment the patient should lie on his breast, in which position the urine must also be frequently passed. The sutures are to be removed on the seventh or eighth day, and two days later the bowels can be opened. Should the patient have any trouble in passing his water, the soft catheter can be introduced into the bladder several times during the twenty-four hours, for the more empty the viscus is kept the greater the probability of success in the treatment.

Vesico-Pubic or Inguinal Fistulæ follow wounds and abscesses in the cellular tissue around the bladder and also in its walls. In cases of cystocele which have been mistaken for abscess or cysts and laid open, such fistulæ will be likely to form. There may be several openings in the abdominal region, though but a single one in the bladder. A lady under my care had, in consequence of a pelvic cellulitis terminating in suppuration, five inguinal hypogastric fistulæ on the right side communicating with the bladder. Though of over one year's standing, they had, at the time of my last visit, all closed except two by the simple expedient of emptying the bladder while lying on the left side. The remaining fistulæ were rapidly diminishing.

The *treatment* consists in keeping the bladder empty by frequently urinating, and in a position of the body which will divert the urine from the abnormal opening. In some instances frequent catheterization will be preferable to voluntary micturition, as the muscular walls of the organ will be less disturbed by the former.

Vesico-vaginal fistula will be considered under the surgical diseases of women.

Varices.

True varices are very rarely seen in the veins of the body or fundus of the bladder, though the serpentine form of the vessels would appear to be favorable to such dilatations. At the neck of the organ and around the prostate a condition of this kind is not unusual. Morgagni and Chopart have described such enlargements of these vessels, and I have myself seen them similarly dilated and convoluted in the cadaver, and in one instance was able to make successfully an injection of these canals. Any obstruction, as stone in the bladder or hypertrophy of the prostate body, will, by causing vascular congestion and by interrupting the free return of the venous blood, tend to induce this condition of the vessels.

Doubtless some of those hemorrhages which are encountered in prostatic diseases, or which follow the lateral operation for stone, may be properly referred to a varicose state of the prostatic and vesical veins.

Hæmaturia.

Hæmaturia is a term used to express the presence of blood in the urine, but has no reference to the source from which the hemorrhage comes, and is, therefore, employed in a generic sense. The kidneys, the ureters, the bladder, and the urethra being continuous portions of the genito-urinary apparatus, blood may come from any part of this extended surface and appear in the urine. At present it is only with hemorrhage from the bladder that we have to deal.

Vesical hemorrhage may be idiopathic, traumatic, or pathological. Persons somewhat advanced in life suffer more frequently from this than the young or the middle-aged. The causes of idiopathic vesical hemorrhage are alterations in the structure of the blood, obstruction to the circulation through the ascending vena cava, and the action of certain drugs.

Under the first, or *blood-changes*, may be mentioned those cases of bleeding from the bladder which are seen to accompany purpura, scurvy, typhoid, and some exanthematous diseases. No visible lesion of vessels can be detected in these cases of hemorrhage, the blood appearing by an exudation from the vessels of the mucous membrane.

Under the head of *obstructive* causes will come enlargement and indurations of the liver, and abdominal tumors. These, by pressing on the vena cava, prevent an uninterrupted flow of venous blood to the right side of the heart, and consequently cause an over-distended condition of the vesical veins.

The medicinal substances which act by producing irritation and congestion of the mucous membrane of the neck of the bladder, and not infrequently the loss of blood, are cantharides and the terebinthines, particularly oil of turpentine.

The *traumatic* causes most frequently concerned in producing vesical hemorrhage are stone, the rough use of the catheter, of the lithotrite, or of the sound, blows or falls on the lower part of the abdomen or on the pelvis, wounds, incised, gunshot, or punctured, sexual excesses, etc.

The *pathological* causes are ulceration, cancer, and varices, and finally, in certain Eastern countries, vascular congestion caused by a peculiar parasite—the *Bilharzia hæmatobia*—which makes its habitation in the coats of the bladder. Dr. Barry, of Dublin, has recorded the case of a man who had suffered for several years from pain and vesical irritation, attended with the discharge of bloody urine, who promptly recovered on passing from the bladder a worm one inch in length. Mr. Lawrence mentions a similar case in a female twenty-four years old, who, at different times in the course of a year, passed from the bladder between eight hundred and one thousand worms.

Vesical hemorrhage is sometimes vicarious, designed in women to compensate for the suppressed menstrual flow, and in men for the sudden arrest of hemorrhoidal bleeding. The amount of blood which may appear in the urine is subject to great variation. It may be so small in quantity as to be detectable only by a microscopic examination, or it may be so great as to fill the bladder with coagula. The presence of even a very little blood imparts a smoky or mahogany-brown color to the urine.

DIAGNOSIS.—Bloody urine always creates alarm, and persons so affected apply early for medical counsel. Occasionally unnecessary anxiety is experienced by individuals who find their urine to have a very high color, and suppose the tint to depend on the presence of blood, when it is entirely free from that fluid. There are some substances—for example, the fig cactus—which, when eaten, impart to the renal secretions a color closely resembling that of blood; the same is true of *santonin* when used internally: consequently the representations of patients must never be taken on a subject of this nature without being confirmed by medical examination.

Urine containing blood will always be found to be albuminous. As the extended mucous tract belonging to the genito-urinary organs may furnish a hemorrhage at any point from the kidneys to the urinary meatus, it is not always easy to ascertain the true source of blood which appears in the urine.

In cases of penetrating wounds, fractures, and other injuries of the pelvis when the violence can be traced directly to the bladder, or when, after the use of instruments in the viscus, bleeding follows, there will be little difficulty in conjecturing its source. But when no such clue is possessed, the solution of the difficulty is not always an easy one. In instituting an inquiry to clear up the obscurity, it will be necessary to proceed on the principle of exclusion. Renal hæmaturia is usually preceded by a history of kidney disease, as albuminous urine, casts of the uriniferous tubes (fatty and granular), œdema, headaches, and retinal changes; or if from a renal calculus lodged in one of the infundibula or in the pelvis of the organ, there will have been pain in the back, pain along the course of the ureter, or in the

testicle, and probably an attack of renal colic with blood-casts and abundance of spherical epithelium. When the hemorrhage is renal and has followed an injury about the loins, as in lifting heavy weights, there is more or less uneasiness experienced in the lumbar region. The blood which reaches the bladder from the kidney, entering the former viscus in drops and rarely passed pure, but in clots, is generally uniformly diffused through the urine, so as to impart a dark, smoky appearance to the secretion. Exceptions to this will be noticed in the hemorrhage following malignant growths of the kidney, and often after severe traumatic violence. In hemorrhage suspected to be from the prostate, we should expect to find the gland enlarged, probably tender, the patient over fifty years of age, and a previous history of bladder irritation.

If stricture of the urethra is the cause of bleeding, there will have been experienced the signs of obstruction to the free flow of urine, a diminished stream, and the usual information may be acquired by the use of the bougie. Clots are often discharged in such cases moulded into cylinders having the form of the urethra. Hemorrhage from the ureters will probably be the result of an unsuspected calculus, and is marked by intense and sudden pain, radiating towards the back, thighs, and testicles, with retraction of the latter, and accompanied by nausea, vomiting, and prostration.

The sudden subsidence of these symptoms in the event of the calculus passing into the bladder will furnish additional and decisive evidence.

If, therefore, none of the characteristics indicated are present in a case of hæmaturia, there will be strong reasons for believing that its source is the bladder. There will be additional and certain confirmation if, on exploration of the viscus with the sound, a stone or some morbid growth is detected, or if the urine contains a large amount of mucus, evidence of chronic cystitis.

When the amount of blood is considerable and derived from the vessels near to the neck of the bladder, or from the prostate body, the coagula collect in the bladder, and, being dissolved by the urine, are discharged in micriturition, the mixture presenting very much the appearance of coffee-grounds.

When hæmaturia is produced by the presence of a malignant growth in some part of the urinary tract, not unfrequently the tumor may be discovered by a careful examination made in the hypogastric, the lumbar, or the iliac region, or through the rectum. Even when not appreciable to the touch, such disease will sometimes be revealed by shreds of decomposed tissue, and by the signs of failing health.

Important information as to the source of hæmaturia may also be obtained by inspecting the blood-clots which may be passed. These will often assume the form of the canal from which they proceed.

Mr. Hilton has given considerable importance to this subject.

By floating the clot in water any peculiarities of form which it may possess will be unfolded and displayed. Coagula from the bladder are represented as being flattened, circular, and irregular in their outline, with beveled and serrated margins. Long, slender, worm-like coagula indicate that the clots are derived from the ureter; when fashioned into round cylinders, they probably are moulded in the membranous or spongy urethra; and when formed in the prostatic sinus, they are fusiform and flattened.

In cases of hemorrhage excited by the presence of the *Bilharzia hæmatobia*, the nature of the cause may be detected by finding in the urine the ova or embryos of these parasites.

TREATMENT.—In the treatment of hemorrhage from the bladder, it is all-important that the cause on which it depends shall be ascertained. When it arises from stone, its extraction constitutes the remedy; when it has been caused by the rough use of instruments and caustics, rest in the recumbent position, with ice applied to the perineum or over the hypogastrium, will generally arrest the flow.

When the bleeding is idiopathic, in addition to rest and recumbency it may

be necessary to administer hæmostatics, gallic acid, acetate of lead, alum, creasote, aromatic sulphuric acid, tincture of the chloride of iron, Monsel's solution of iron, fluid extract of ergot, and turpentine being the most valuable. The last two may be administered together, and are particularly efficacious. Fifteen drops of the fluid extract of ergot and six drops of the oil of turpentine may be given in some mucilage once every hour until the desired effect is produced. Small pieces of ice cut into a conical form and introduced into the rectum will also be found useful; and the same is true of the ice-bag applied to the perineum.

As in other forms of hemorrhage, so in this, opium will be found to be of great value, and may be given either by the mouth or by the rectum in the form of suppositories.

In those cases of vesical hemorrhage in which there is a constant passive leakage, and which resist the remedial measures already indicated, injections into the bladder of Monsel's solution of iron (twenty drops of the iron to one ounce of water) will exert a salutary effect. Nitrate of silver has also been employed by Thompson with a good effect in the proportion of one grain of the salt to an ounce of distilled water.

When the hemorrhage proceeds from a vesical growth, and is of a nature to admit of removal, it should be removed by the median perineal cystotomy in the male, and through the dilated urethra in the female. In two instances I have twisted off and extracted large papillary fibromata in this way from the female bladder, with the effect of giving long periods of relief. Where from repeated attacks of vesical hemorrhage the vessels have been drained and anæmia induced, preparations of iron will be demanded, as the tincture of the sesquichloride or of the perntrate, not only on account of their tonic effects, but also for their astringent properties. Nor must the proper regulation of the diet be overlooked in this form of hæmaturia. Stimulating articles of food will be out of place, and solid nourishment will be preferable to liquid, except where there is much exhaustion, when milk and animal broths will be required to replenish the vessels.

When stimulants are required, the red wines, being rich in tannic acid, should be preferred.

When coagula accumulate in the bladder, there should be no premature meddling or over-anxiety to dislodge the blood from the bladder by the use of the catheter. Instrumental interference may open anew the vessels which have ceased to bleed.

The urine is an expellant of these blood-clots, and in time will interpenetrate the latter and dissolve them sufficiently to admit of their being discharged as a dark, sanious-looking fluid.

When, however, the bladder becomes much distended by the accumulation of blood, and is unable to free itself, resort must be had to the large catheter with which to break up the coagulum, and through which, by passing cold water and applying suction, the organ may be unloaded.

Should all measures fail to effect the end in view and the symptoms continue urgent, the surgeon would be justified in opening the bladder, as in the lateral operation for stone, and clearing out its contents with the scoop and by repeated washings.

Adynamia and Paralysis of the Bladder.

Adynamia, or loss of power in the walls of the bladder, whereby the organ is rendered unable to expel its contents, may arise from centric or from eccentric or peripheral causes.

When from the former, that is, from some lesion of the brain or the spinal marrow, it is usually termed *paralysis*; when from the latter, or from causes affecting the conducting properties of the nerves, *atony*.

It is necessary, in treating of this subject, to have clear and well-defined ideas with regard to certain expressions in common use, as from the vague

manner in which they are employed they are liable to convey erroneous impressions. First, there may be an entire inability of the bladder to expel its contents without any paralysis whatever, as in cases of obstruction from reflex contraction or spasm of the sphincter vesicæ, consequent on the ligation of hemorrhoids, or from an irritable stricture, or from ascarides, or from hypertrophy of the prostate. But it will be observed that in such a condition the difficulty does not result from the *want of power*, but from causes which render its exercise futile. Such a disability constitutes an example of *obstructive retention*. Again, retention may occur from psychical causes, in which there is an absence, not of power, but of its co-ordination. It may also arise after an amputation or a fracture of the leg, when the inability to urinate is in great measure to be attributed to position of the body, the act requiring for its execution a new and untried exercise of muscular power.

The peripheral or eccentric causes which produce partial or complete loss of power in the walls of the bladder are the following:

1. *Over-distention*.—An individual may from the force of circumstances, from feelings of modesty, or from causes which lower the sensibility of the brain to the ordinary wants of the organs (as intoxication), allow the bladder to become so distended with urine that the nerves, in consequence of the pressure and stretching to which they are subjected, are rendered unfit for transmitting those motor impulses to its walls which are necessary for their contraction. This loss of power from peripheral causes is frequently met with in aged persons, especially in those whose occupations have been of a sedentary nature. Book-keepers and men of literary pursuits, absorbed with their calculations and studies, often become insensible to the usual promptings of the organ, and allow the inordinate accumulation to be repeated until there follows a permanent atony. In addition to the internal pressure from the urine, there may be pressure from without, inducing such lesion of the nerves of the bladder as will destroy the contractility of its walls for a long time, as when a blow or other injury is received in the hypogastric region, or when an accoucheur, during the delay of the foetal head in its transit through the pelvic basin, allows the bladder to become distended with urine.

The evil resulting from over-distention of the bladder does not always terminate with the removal of its contents. This may be followed by hemorrhage, especially when the whole of the accumulation is removed at once, by cystitis from the decomposition of urine, and by an enervation which, disturbing the nutrition of the organ, inaugurates fatty degeneration of its muscular wall.

This atrophy of the walls of the bladder is liable to occur under other conditions than those of distention. It may be a part of that general wasting which marks the decay of the human body in advanced life, and it may also follow in consequence of the pressure of abdominal or pelvic tumors on the principal blood-vessels or nerves which supply the bladder, thus inducing atrophy by interrupting the necessary supply of blood or nerve-force.

2. *Centric paralysis* arises from causes affecting either the brain or the spinal marrow. Thus, after concussion, compression, meningitis, encephalitis, myelitis, fractures of the vertebræ, syphilitic and other deposits, there may be a complete or a partial loss of power in the bladder. Even where no actual lesion of the cerebro-spinal axis exists, there may be present a paralysis from functional disturbance of these centres of nerve-power. Examples of this nature are witnessed in low forms of fever, in which, partly from the apathetic stupor of the mind, the result of a vitiated blood circulating in the brain, and partly from a defective nerve-energy, the patient is not quick to recognize the urgent necessity of the organs, and the bladder is allowed to become distended. These cases are often overlooked by the careless or ignorant physician until the life of the patient is placed in the greatest jeopardy. Belonging to the same category of functional disability are those cases of vesical paralysis which result from exhaustion of nerve-power, as from great sexual excess, in which the constantly repeated demands or drafts on the

source whence the genito-urinary apparatus is endowed with power have exhausted the supply.

Paralysis occasionally follows the use of certain drugs, as hyoscyamus and belladonna.

In most instances of paralysis of the bladder, especially from centric causes, the over-distention is after a time followed by dribbling,—a fact which should not escape notice, as it might lead to serious consequences if the physician supposed such a condition to be incompatible with an undue accumulation of urine in the bladder.

In consequence of the manner in which the bladder is supplied with nerves, the body of the organ may be paralyzed and its neck remain unaffected. Or the neck may be the seat of the paresis and the body retain its functional power. In the former case there will be retention of urine, in the latter there will be incontinence.

Whatever may be the origin of the paralysis, whether from centric or other causes, it is soon succeeded by alterations in the constitution of the urine, in which the secretion becomes alkaline, muddy, emits an ammoniacal odor from the decomposition of urea, and is loaded with amorphous phosphates. These, reacting on the mucus of the bladder, not only provoke a chronic or catarrhal cystitis, but also lay the foundation for calculous concretions, incrustations of the lining membrane of the bladder, ulceration, and even sloughing of its coats. The general health soon suffers from the absorption of the constituents of the urine, which, circulating in the blood, seriously impair the nutrition of the body, and exert a poisonous influence on the skin and on the brain, as seen in the cutaneous eruptions which break out over the surface of the body, and in the fatal coma which occasionally supervenes.

The signs of an over-distended bladder are sufficiently obvious to prevent any mistake from being committed.

A tumor or swelling having a regular outline will occupy the hypogastric or the umbilical region, which on percussion yields a *dull* or *flat* percussion-note.

When the paralysis has been induced by peripheral causes, the accumulation or distention will have been marked by uneasiness, restlessness, pain, and fullness, with frequent but ineffectual efforts to urinate.

DIAGNOSIS.—The diagnosis of paralytic or of adynamic retention from obstruction, and of reflex retention, may be easily established by the use of the catheter. In the former the instrument will pass readily into the bladder without encountering any opposition. The escape of the urine will be unlike in the two conditions. In the former the water, not being propelled by the contraction of the walls of the bladder, will flow in a slow stream, while in the latter (reflex retention) it will be discharged forcibly, even impetuously.

PROGNOSIS.—This can be formed only after a careful consideration of the causes on which the disability depends. When produced by carelessness or supersensitiveness, and in a young person, and when early relieved, the muscular tonicity will in all probability be quickly recovered and no inconvenience will follow.

In persons somewhat advanced in life, and in whom the adynamic state of the organ has been slowly increasing, or who have had several attacks of retention, the outlook will be unfavorable. When the enervation or paralysis is the effect of exhaustion, as in typhoid fever, or from simple concussion of the cerebro-spinal axis, the power will return with convalescence. When following compression of the brain from depressed bone, the elevation of the fragments is generally followed by a recovery of muscular power in the organ. The most unpromising cases are those which have been produced by lesion of the brain or of the spinal marrow, recovery seldom taking place.

TREATMENT.—The indications in the treatment of an atonic or a paralyzed bladder are, first, to remove as quickly as possible the contents of the viscus, and, secondly, to endeavor to restore the lost muscular contractility.

The use of the catheter will accomplish the first, and it will be necessary

to repeat it three or four times in the twenty-four hours. By this means the walls of the organ are preserved in a relaxed or collapsed state, which will conduce to their recovery. Besides this there is another very important end secured, which is to prevent those changes which are certain to follow the presence of residual urine, which is a fruitful source of evil, both local and general. When the distention is great, the removal of the water should be effected gradually, and not all at one time. A contrary course may induce fatal prostration or severe hemorrhage. Even when patients have recovered what appears to be a fair power over the bladder, there will often remain a variable quantity of urine, from one to several ounces, which cannot be detected in any other way than by introducing the catheter. As long as this is the case there is danger, and the instrument should be used. The *soft* catheter should always be employed, as by its flexibility the *bas-fond* of the bladder, where the last pool of urine lies, with its sedimentary deposits, can be most satisfactorily reached. As the necessity for catheterization will often exist for a long time, the patient must be instructed in the use of the instrument; and, as in many cases the urethra possesses little or no sensibility, the advantage of the soft catheter is obvious, since the canal is not likely to be damaged in its introduction. While it is important to remove the urine by instrumental interference, it is at the same time possible to carry even this measure too far. The bladder, if constantly helped in this way, may learn to rely on artificial assistance. Whenever, therefore, the organ has recovered to a reasonable degree the power to contract on its contents (as will appear by the force with which the urine flows), the instrument should be employed less frequently, and the patient urged to exercise all possible voluntary power to empty the viscus. This very act of volition will impart a new stimulus to the organ and hasten the cure.

In addition to the local treatment, benefit will accrue from the exhibition of internal remedies. In many cases of paralysis of the bladder the determining cause affects to some extent the intestinal tract, thus favoring the formation of fecal accumulations. It will be desirable, therefore, to secure proper alvine evacuations by the administration occasionally of gentle cathartics. They will also be indicated in inflammatory conditions of the brain and spinal marrow or their membranes. When the necessity for a general tonic exists, the tincture of the chloride of iron and quinine may also be administered. When there is reason to believe that the offending cause is a gummy tumor, or some other morbid change in the cerebral or spinal centre, iodide of potassium, with or without mercury, will be demanded. When the cause which was actively concerned has been removed, and the vesical disability appears to depend on inertia of the muscular walls of the organ or of the centre from which they are energized, strychnine and ergot may be given, either singly or conjointly, with advantage (strychnine has been injected into the bladder in a few instances, it is said, with a good effect). Electricity has also been applied by passing the current directly through the walls of the bladder, one insulated electrode being introduced into the bladder after the urine has been removed, and the other electrode, provided with a moistened sponge, being applied alternately over the hypogastrium and the lumbar region, or over the perineum. Occasionally the second electrode is introduced into the rectum,—of course without the sponge.

In addition to these measures, blisters over the lumbar and sacral regions, and the cold douche applied to the back, to the perineum, and to the lower part of the abdomen, will be valuable adjuvants.

Incontinence of Urine.

Incontinence of urine may exist at any period of life, though most common in children and in aged persons. It is subject to great variations; the urine may escape as fast as it is secreted, or it may be retained until several ounces

accumulate, and then be discharged *guttatim* or in a feeble stream: occasionally it is projected with some force in jets.

Very frequently in children and in youths the incontinence or enuresis exists only in the night and during sleep, when it is termed *nocturnal incontinence*.

The causes of incontinence are *traumatic, mechanical, chemical, inflammatory, and reflex*.

1. *Traumatic incontinence* may result from a fistulous opening remaining after the operation for stone, or from the presence of a recto-vesical or vesico-vaginal fistula. The same defect may follow a blow or other injury applied over the lumbar or the sacral region. In women it may be caused by the foetal head pressing the bladder for a long time during a protracted labor. The displacement or crumbling of the vertebrae in children suffering from Pott's disease of the spine, by damaging the medulla spinalis or the nerves which go to form a part of the vesical plexus, will also render the organ incapable of retaining its contents. The treatment of traumatic incontinence will be indicated by the cause. If from fistulae, they must be closed by an operation, or by other measures, when practicable; if from violence, as blows, kicks, falls, etc., rest, and after a time the use of strychnia will be of great advantage; if from caries of the vertebrae, suspension of the body and the application of a plaster or leather jacket will afford the fairest prospect of relief.

2. *Mechanical incontinence* often follows hypertrophy of the prostate body, more particularly when the disease affects the middle lobe of the gland, or when a myomatous fibroma is developed in its structure. Either of these growths, projecting into the neck of the bladder, serves to open its canal by acting as a wedge.

The frequent introduction of large bougies into the bladder may be followed by a patulous state of the neck of the viscus, which will allow more or less dribbling. The mechanical distention of the bladder consequent on obstruction, either from enlargement of the prostate or from urethral stricture, may also so weaken the walls of the organ as to induce a dribbling or an overflow from paresis of the sphincter vesicae.

When the incontinence is the result of morbid growths dilating the neck of the viscus, the case is not amenable to treatment; a spontaneous relief is in rare instances obtained by a change in the direction of growth of the tumor, by which the latter is drawn away from the orifice of the urethra. Incontinence following the use of large bougies in the treatment of stricture should warn the surgeon against extreme dilatation.

3. *Chemical incontinence* is the result of changes in the constitution of the urine, in which the secretion becomes intensely acid, or is loaded with crystals of uric acid or oxalate of lime, the irritation from which on the mucous lining of the bladder causes contraction of the detrusor muscle and a frequent expulsion of the urine. This annoying condition can generally be corrected by the exhibition of alkalies, in order to remove the acidity of the secretion, by carefully regulating the diet so as to correct any error in the process of digestion, and by the subsequent administration of tonics, particularly the mineral acids, as nitric or nitro-muriatic acid. In such cases a decided improvement will often follow the use of a pill consisting of *pepsina* and strychnia, five grains of the former and one-thirtieth of a grain of the latter, taken on sitting down to meals.

4. *Inflammatory incontinence* is that form of enuresis which is produced by structural changes in the mucous membrane and the muscles both of the bladder and of the urethra. Thus, a rough stone is capable of creating a cystitis which will render the bladder perfectly intolerant of the presence of urine. The same effect may follow the extension into the viscus of gonorrhoeal urethritis, or of a prostatitis, or tubercular or syphilitic ulceration of the neck of the organ.

Inflammatory fullness of the vessels, by teasing the walls of the bladder,

induces concentric muscular hypertrophy, which, by diminishing the cavity of the organ, renders it unable to retain more than a small quantity of urine at a time.

Again, incontinence may follow those inflammatory changes which are produced in the compressor urethræ muscle by strictures situated in the membranous portion of the urethra, by which that muscle is converted into dense fibrous tissue, and consequently becomes useless to guard the canal against the involuntary intrusion of the urine. The treatment must be directed to the subjugation of the inflammation by rest in the recumbent position, leeches to the perineum, the hot hip-bath, and anodyne injections or suppositories.

5. *Reflex* incontinence arises from a variety of causes, among which may be named a contracted prepuce, collections of smegma behind the corona of the glans penis, rectal irritation the result of worms or polypi, change in the quality of the urine, masturbation, etc. Many cases of juvenile incontinence are due to the operation of some one of the above causes, and are promptly and radically cured by their removal. Boys are more frequently affected than girls.

During my connection with the board of management of the House of Refuge in the city of Philadelphia, urinary incontinence became so general among the boys that the attention of Dr. Addinell Hewson, the medical attendant of the institution, was called to it, and he made a very thorough inquiry into the subject. Of 75 boys affected with enuresis, 34 were negroes, their ages varying from seven to eighteen. A very large proportion of these children belonged to the unthrifty, neglected, and destitute class, and many of them were far from being vigorous, healthy lads. One-third of the number suffered from ascarides, 20 from constipation, a few had herpes, and 18 acknowledged the habit of masturbation; there were reasons for supposing that almost all were addicted to this vice. The incontinence rapidly disappeared under a regulated diet, and the use of laxatives, succus belladonnæ, alkalies, and turpentine, according to the individual necessities, with the aid of a little monitory discipline.

There are, however, a considerable number of cases of this troublesome affection, in both boys and girls, which cannot be traced to any of the aforementioned causes, and which are most probably dependent on peculiarities of a constitutional nature, in which the brain or spinal marrow participates. They are generally met with in young boys of fair complexion, feeble organization, and nervous excitability, to whom the disability clings, in defiance of all treatment, until the period of puberty, or for some time after. Many persons who suffer from seminal emissions have been victims of urinary incontinence previous to puberty; and, as the nerves which supply the genital and the urinary organs are so closely related, it is reasonable to suppose that the reciprocal influence of the two must be very great.

In addition to the varieties of urinary incontinence already named, there are occasional cases of the affection, generally in adults, in which vesical disability appears to depend on miasmatic causes, the inference of such an origin being drawn from the periodicity of the attacks and the existence of chills and rigors. These cases require the use of full doses of quinine.

TREATMENT.—In the treatment of juvenile incontinence a most careful inquiry should be instituted with a view to discover if there exists any local cause likely to produce or perpetuate the affection. If there is present a contracted prepuce, circumcision or incision will be required; if the lower bowel is infected with ascarides, injections of carbolic acid and turpentine, or of salt and water; if there is constipation, it must be relieved by the use of saline laxatives; if the urine is unduly acid, it must be corrected with alkalies, as the bicarbonate of soda; if, on exploring the bladder, a stone is discovered, relief can be obtained only by its removal; and if the digestive organs are deranged, and there are signs of defective nutrition, iron, strychnine, and pepsin, separately or in conjunction, will be required. With a view

to lower the sensibility of the bladder and the cerebro-spinal axis, no remedy is so deserving of trial in urinary incontinence as belladonna. From three to five drops of the tincture, or the same amount of the juice of the leaves, may be given to a child four or five years old three times a day. A combination of this drug with the bromide of potassium will sometimes prove more efficacious than the belladonna alone. A pill or emulsion consisting of camphor and belladonna, given three or four times daily to patients under eight or ten years of age, will, in some instances, exert an excellent effect; gum camphor, gr. $\frac{1}{4}$; extract of belladonna, gr. $\frac{1}{12}$ to $\frac{1}{8}$. In pale, weakly, and strumous children cod-liver oil and the syrup of the iodide of iron will be found useful.

The application of a blister to the nape of the neck will frequently effect a perfect cure. Cold hip-baths or douches of cold water will tend to lower the sensibility of the neck of the bladder, by imparting general tone to the pelvic organs. When the patient is capable of being reasoned with, the physician should enjoin the necessity of lying upon the side and of rising once or twice in the course of the night and emptying the bladder, or the object may be obtained by similar instructions given to the nurse or to the parent; as the concentrated quality of the nocturnal urine tends to produce such an impression on the mucous lining of the bladder as will be likely to cause its expulsion. The practice of attempting the cure of urinary incontinence by intimidation, and sometimes by brutal chastisement, is, even at the present time, not uncommon. That there is an exceptional case now and then to be met with of a boy utterly indifferent to all feelings of self-respect and of personal cleanliness, who will yield to the promptings of nature's calls without reference to place, time, or circumstances, cannot be denied, and then the judicious enforcement of the Salomonic injunction will wonderfully conduce to a cure; but these cases are so rare that, as in the matter of capital punishment, where it is better that ten guilty persons should escape than that one innocent man should suffer, rather than subject a single child, whose infirmity is real, to such barbarism, it is better to allow many, whose incontinence is unreal, to escape what they deserve.

In obstinate cases of urinary incontinence, after other remedies have failed to afford relief, the prostatic urethra and the neck of the bladder may be lightly cauterized with the nitrate of silver. For this purpose a solution of eight grains of the salt to one ounce of distilled water should be accurately applied by a catheter canula containing a stylet around the extremity of which is wrapped a dossil of cotton, which, after being saturated with the solution, can be protruded from the canula when the latter has been passed along the urethra to the portion of the canal to be cauterized. In incurable cases of incontinence in the male, it will be necessary, in order that the presence of the patient may be rendered tolerable to those about him, that he should wear a urinal.

Tumors of the Bladder.

The morbid growths which are met with in the bladder are both *benign* and *malignant*.

Fibroma.—Tumors of this class are the most common. The histological elements of fibromata are not alike. They are sometimes truncated or boss-like in form, arising from the inferior wall of the bladder with a sessile attachment, and when examined are found to consist of a dense, compact interlacing of connective-tissue fibres.

An eminent citizen of Philadelphia whom I attended for two years, and who had previously had a stone crushed in London, died from what was supposed to be cystitis. An examination of the bladder after death revealed the presence of a dense fibroma, about the size of a walnut, which had developed in the lower wall of the organ. In addition to the ordinary symptoms of

catarrhal cystitis, extreme pain and spasm of the viscus were permanent attendants of the disease.

Villous Fibroma, or Papilloma, is frequently met with in the bladder under different forms as to external configuration, sometimes presenting a dendritic, complex arrangement of branches or branchlets resembling a tree, at other times in the shape of truncated elevations with a raspberry-like surface, again as wart-like eminences, resembling miniature stems of coral, and finally as pedunculated, gelatinous outgrowths, bristling with hair-like papillæ or villi.

In all these different varieties the histological elements are the same, formed of a series of branching papillæ or villi, more or less complex, which consist of an extremely delicate prolongation of the normal connective tissue of the bladder, inclosing one or more capillary loops, and surmounted with round, columnar, or many-sided epithelia.

Papillomata may be single or multiple, and are often scattered over a considerable portion of the mucous surface of the bladder (Fig. 1318.) They are more common in women than in men, and are frequently met with in children. When the fibrous element prevails, they seldom bleed. Sometimes they grow until the bladder is almost filled with their soft branches.

I removed in one instance a growth of this nature from the bladder of a lady, springing from one side of the organ, and which, so far as I was able to judge from an exploration of the organ with the finger, occupied more than one-half of the viscus. The rapid growth of these neoplasms, and their soft and vascular nature, occasion not only great vesical irritation and urinary obstruction, together with incessant and painful micturition, but often also slight bleeding. The urine is frequently mixed with mucus, and sometimes with detached fragments of the growth.

It is quite possible to mistake such a tumor for stone in the bladder. In a female patient under the care of Dr. Bodine, who presented not only the rational signs of calculus, but also the decisive physical sign yielded by the sound, I found, on dilating the urethra and introducing my finger into the bladder, a hard body the size of a small orange and having an irregular surface. It was moored by a narrow base to the side of the organ. Under pressure it broke down, and proved to be a papilloma, which had been completely incrustated with the lime salts of the urine. These growths invariably return when removed, and may be regarded as incurable.

Polypoid Fibroma, the rarest of all papillary growths in the bladder, when present is generally pedunculated, and consists of a basement layer of fine, loosely intersecting filaments of connective tissue, covered with vesical epithelium and supplied very sparsely with blood-vessels. It occurs with nearly equal frequency in males and in females. The symptoms which indicate the existence of vesical polypi are frequent urination and sometimes sudden retention, in consequence of the growth (when the pedicle is long) floating into the neck of the bladder, or even into the urethra. In a singular case of this nature which I saw, the lady had suffered from great irritability of the bladder for seventeen years, and had been under the care,

FIG. 1318.



Multiple papilloma of the bladder.

at different times, of a number of the most eminent medical men in Philadelphia, without obtaining relief. She was at one time lithotomized, under the impression that a stone was concealed in the bladder. Frequently during the years of suffering the urethra and bladder had been explored with care, but without offering any clue to the disease, until finally all hope of obtaining relief was abandoned. This lady, finally, was seized with partial retention, and sent for a physician in the southern part of the city, who, on making examination, discovered a small, soft, gelatinoid body like a pea lodged in the urethra, and attached to the interior of the bladder by a long, thread-like pedicle. The polypus was extracted, and with its removal disappeared all the vesical distress of the patient.

Papillary Adenoma differs from the other varieties of fibrous vesical growths in having glandules imbedded in a stroma of connective tissue. It usually rises from the mucous surface of the bladder as a convex eminence with a broad base. In addition to the symptoms of vesical irritation and obstruction which characterize the existence of this papillary growth in the bladder, valuable information may be acquired by hypogastric palpation and the use of the sound in the male, and by the finger in the female, which can be readily introduced into the viscus after the rapid dilatation of the urethra.

Carcinoma of the Bladder, though rarely occurring as a primary affection, is frequently a secondary deposit when the disease exists elsewhere, or it may be propagated to the bladder by continuity of structure, when the vagina, the uterus, the rectum, or the prostate body is the seat of a malignant growth.

The form under which it appears is that of epithelial cancer, and chiefly in the male, of mature or advanced life. Affecting as it almost invariably does the neck and the lower wall of the bladder contiguous to the neck, the disease, when primary, is believed to originate in the epithelium of the glandular portion of the prostate body.

Epithelioma varies much in its behavior, sometimes concentrating its ravages on a limited portion of the bladder, sending into its cavity a large mass of alveolated connective tissue, infiltrated with disorderly arranged epithelia, and giving to the growth an induration readily mistaken for scirrhus. Or instead of one there may be several tuber-like projections. These growths after a time ulcerate, presenting the same ragged appearance and covered with the same foul discharge which characterize the cutaneous form of the disease. In other instances the tendency of the affection is to become diffused, infiltrating not simply the mucous and submucous tissues, but all the layers of the bladder, and extending to the ureter, seminal vesicles, and contiguous parts. One of the earliest signs of malignant disease of the bladder is hemorrhage. The pain extends to the lumbar and sacral regions and to the perineum, and is often lancinating in its character; the symptoms of vesical irritation, obstruction, and dysuria are also present.

The progress of epithelioma is generally rapid, during which the bladder is likely to become opened by ulceration, permitting the escape of urine, and followed by all the evils of pelvic extravasation, among which the most common is peritonitis. Few patients survive more than from twelve to eighteen months. In one case which I saw with Professor Da Costa, there was reason to believe the disease had existed for five years; in a second which was under the care of Drs. Steller and Newcomet, the individual survived three years; and in a third case, which I saw in connection with Dr. Samuel Murphy, the patient lived about the same length of time. There are several recorded examples of the disease in which the fatal termination was postponed for a much longer time.

DIAGNOSIS.—As the signs which accompany epithelioma of the bladder belong to other growths of this viscus, there must always remain some un-

certainty in the diagnosis. Generally, however, the suffering in epithelioma, where ulceration exists, is exceptionally severe and the vesical tenesmus exceedingly distressing. In papillomata the urine usually contains characteristic debris. Sometimes a fragment of a vesical growth can be pinched off with the small lithotrite and its nature determined microscopically. Sometimes bimanual pressure, two fingers of one hand being introduced into the rectum and those of the other hand applied above the pubes,—the patient being etherized,—will enable the surgeon to discover a vesical growth. The most certain of all methods, however, consists in a median perineal incision and exploration by the finger in the male. In females the examination can be made with the finger through the urethra. Dr. Nitze is an earnest advocate of electro-endoscopy as a means of diagnosis.

Sarcoma of the Bladder.—Several growths taken from the bladder have been described as sarcoma. There is little doubt that tumors of this nature find a habitat in this organ. Those described have belonged to the round-celled variety of the disease.

TREATMENT OF TUMORS OF THE BLADDER.—Though in some of these morbid growths of the bladder little can be done except to alleviate the urgency of the symptoms, yet in others the surgeon is able, by an operation, to eradicate the disease permanently. When the object is palliation, our remedies must be addressed to the relief of pain and vesical tenesmus; and suppositories of opium and belladonna or hyoscyamus will afford the greatest relief. When hemorrhage exists, such articles as gallic acid, turpentine, aromatic sulphuric acid, fluid extract of ergot, or pernitrate of iron may be given. The application of ice-bags to the perineum and above the pubes, and injections of cold water into the rectum or the vagina, or sometimes into the bladder, will prove powerful adjuvants in arresting the bleeding. In addition to these measures, rest in the recumbent position is of the first importance, taking care to keep the bowels regular and to avoid stimulants, to use a light, easily-digested diet, and to abstain from all sexual indulgence.

Medicated or astringent injections thrown into the bladder, should the hemorrhage prove obstinate, may be tried, using for this purpose a warm solution of alum, five grains to the ounce of water, or one of Monsel's solution of iron, eight to twelve drops of the iron to one ounce of water. In the female there is no difficulty in gaining access to the growth by a rapid dilatation of the urethra. For this purpose I employ an instrument with three blades (Fig. 1319), which is introduced, closed, into the canal (the patient being etherized), and afterwards expanded to the required degree. After removing the dilator, the finger is next passed into the bladder and the tumor located, when, with a long forceps (Fig. 1320) conducted over the finger to the growth, the latter can be grasped and extracted entire or by installments through the urethra.

When the base of the tumor is broad and will not admit of being twisted away with the forceps, the wire écraseur can be used with the greatest advantage. Cuviale employed for this purpose the lithotrite; the growth, being crushed with the instrument, came away in fragments along with the urine, or was subsequently extracted. The operation is a hazardous one for the bladder, and should not be performed.

In males, when the extraction of a tumor is deemed feasible and proper, the bladder should be opened either through the perineum or above the pubes. Of 16 operations performed for the removal of papillary and sarcomatous tumors from the bladder, tabulated by S. W. Gross,* 6 died and 10 recovered. Four of the patients were males and 12 females; 2 of the fatal

FIG. 1319.



Instrument for dilating the female urethra.

* Gross on the Urinary Organs, third edition, p. 153.

cases were in males and 4 in females. Two cases of my own, both of which recovered, give us a total record of 18 operations, with 12 recoveries. The detachment of the growths was by evulsion, ligation, and scraping.

FIG. 1820.



Forceps for removing fibroma from the female bladder.

Stein, of New York, collected 98 cases of tumors of the bladder removed by operation, 53 of the patients being males and 45 females; 53 recovered and 39 died. Thompson has operated on 41 patients, 34 males and 7 females. The result in 29 cases was as follows: 5 cures, 4 deaths, and 20 greatly relieved.

Sonnenburg,* of Berlin, extirpated the bladder of a female sixty years old, leaving only the posterior wall, with the trigone, and the openings of the ureter. Drainage-tubes were brought through the abdominal incision and the urethra. Three weeks after the operation the patient was doing well.

Tubercle.—Tubercular disease of the bladder, though by no means common, does occasionally occur, but always accompanied by similar disease in other parts more or less closely related to the bladder, as the prostate body, the vesiculæ seminales, the ureter, and especially the kidneys; the ovaries, rectum, and lungs suffer also. Females are less frequently affected than males, and adults are more liable to the disease than either the young or the old. The deposit is found in the mucous and submucous cellular tissue, appearing in small, round, cheesy masses, which frequently coalesce, and eventually soften, forming ragged ulcerations. The tuberculous infiltration progressing, the ulcers often open into one another, causing extensive destruction of the lining membrane of the bladder.

The symptoms are by no means characteristic, differing little from those common to morbid growths in the bladder, namely, frequent and painful micturition, with muco-purulent or bloody urine. The treatment consists in rest in the recumbent position, anodyne suppositories to diminish the vesical irritation, and tonics, with nutritious articles of diet to sustain the general strength. The suffering caused by the urine acting on the ulcerations within the bladder, and the violent tenesmus and spasms of the organ which result, will be alleviated by opening the bladder through the perineum in the male, and through the vagina in the female, and allowing the urine to escape as it enters the viscus. In women, if this operation is declined, some relief will be secured from a forcible dilatation of the urethra and the neck of the bladder to a degree that will for a time paralyze the sphincter vesicæ muscle.

Catheterism.

The introduction of a catheter into the bladder in a normal condition of the urethra is a very simple and easy operation. I have been many times puzzled to comprehend in what consists the difficulty, and sometimes the mortifying failure, which physicians of many years of service in professional work frequently experience when attempting the task.

I have traveled sixty miles to relieve a case of urinary retention, which the local medical attendant had failed, after repeated attempts, to catheterize, where the instrument passed into the bladder as easily as one would walk down a broad highway of the city. It is no unjust reflection on the medical profession to say that catheterization is the worst-done operation in surgery;

* Medical News, January 17, 1885.

and it is no exaggeration to assert that, considering the frequent necessity for the operation, and the lamentable consequences attending the maladroit use of the instrument, none is more important. I think the inaptitude may be traced, first, to a misapprehension in regard to the course of the urethra, which is supposed to be one with a number of curves; and, secondly, to a notion that considerable force is necessary to carry the catheter forward into the bladder; both of which impressions are erroneous. The urethra, when the penis is held in the proper position, has only a single curve, and that a very gradual one, the concavity being above (Fig. 1321), and the force which should be applied to the catheter in conducting it into the bladder is very slight indeed.

While the operation is sufficiently simple in a natural condition of the urethra, it is very different when there are obstructions in the course of the canal. It then becomes one of the most delicate procedures in surgery, and often requires for its successful execution exceptional anatomical knowledge, patience, manual tact, and skill.

Catheters.—There are two kinds of catheters in use,—the *hard* and the *soft*; the former inflexible, and constructed of metal, the other flexible, made by applying to cylinders of linen or silk a solution of caoutchouc.

The *metallic* catheter should be made preferably of silver. It should be perfectly smooth, curved at its vesical extremity, seven millimetres in diameter and ten or eleven inches in length. The beak of the instrument, which must be nicely rounded off, should have on each side a countersunk oval orifice or eye, the margins of which should be perfectly smooth and round.

The other extremity, or handle, of the catheter should be furnished with two rings, by which the instrument, when necessary, can be tied in the bladder, and which indicate the exact position of the catheter when the vesical extremity is in the urethra.

The curve at the vesical extremity should not exceed, it is said, one-third the circumference of a circle whose diameter is three inches and a half. (Fig. 1322.) A trifling deviation from this, however, will not impair the usefulness of the instrument.

FIG. 1321.



Course of the urethra, and the relation of the bladder to the rectum; also the triangular ligament attached above to the arch of the pubes (a), and below embracing the membranous urethra (b); c, the bulbous portion of the corpus spongiosum.

FIG. 1322.



Metallic catheter.

The *elastic* or *gum* catheter, which is soft and flexible, is worthy of high commendation. There is very little skill required for its introduction, and, when used without a stylet, it is incapable of inflicting any injury upon the urethra. Its use may even be intrusted to the patient himself, or to his attendant. These catheters are manufactured in France, England, and recently

in America. I can discover very little difference in their quality. There are three varieties in use, all exceedingly useful. One is quite firm, and admits of being curved into a definite shape by being placed first in warm and afterwards in cold water; it will retain with considerable pertinacity the curve thus given to it. This instrument is often stiffened by the introduction of a stylet. (Fig. 1323.) A second is perfectly flexible, except at its vesical ex-

FIG. 1323.



Soft catheter with stylet.

tremity, which is firm and bent for half an inch, forming an elbow (Mercier catheter); and the third is a soft tube, as flexible as whip-cord. (Fig. 1324.)

FIG. 1324.



Soft catheter, curled, to show its flexibility.

The gum catheter is frequently constructed with an olive-shaped vesical extremity, which facilitates the introduction of the instrument. (Fig. 1325.)

These instruments, however, all deteriorate by use, becoming rough and brittle when exposed long to the action of the urine. On this account they should always be carefully examined after being used, in order to see if any damage has been sustained. I have seen very unpleasant complications follow neglect on this point, the end of the catheter breaking off and remaining in the bladder or the urethra. Great

cleanliness should be observed in the employment of catheters, as it is more than probable that disease may be communicated by carelessness.

FIG. 1325.



Olive-shaped gum catheter.

in this respect. The instrument, after being used, should be thoroughly cleansed by passing through its canal a stream of water and afterwards rubbing its surface dry with a towel or soft piece of flannel. Nothing more effectually prevents the metal from becoming tarnished by exposure to the air, or preserves the exterior of a gum catheter in a smooth condition, than the application of a little cosmoline before laying the instrument aside.

Introduction.—The catheter may be introduced in any position of the patient, sitting, standing, or lying on the back (though the last is generally to be preferred), with the shoulders a little elevated and the thighs drawn up and moderately separated. Standing on whichever side may be most convenient, after rolling back the shirt of the patient, the surgeon, taking the glans penis between the thumb and index and middle fingers, turns the organ upward towards the abdomen, so as to convert the angle formed at the attachment of the penis to the pubes into a curve. The catheter, held in the other hand, with its concavity upward, and previously well oiled with sweet oil, is now introduced into the orifice of the urethra and immediately placed directly opposite to the median line of the body, when it is to be passed downward with a light hand. (Fig. 1326.) The penis at the same time (in order to

keep the urethra stretched) is pushed gently forward on the instrument until the end of the spongy portion of the urethra is reached, when, the handle of the catheter being depressed with a gradual sweep between the thighs of the patient, the point of the instrument passes through the membranous and the prostatic urethra into the bladder. There is not the least necessity for giving the patient any pain, the whole process, from beginning to end, occupying only a few moments.

In what, then, consists the difficulty likely to be experienced by an unpracticed hand in introducing a catheter?

The point of a small instrument may become caught in the lacuna magna or in the orifice of a urethral follicle. In consequence of the incorrect description of the urethra

by some anatomists, another error is frequently made. A bulbous part of the urethra is often spoken of, though none such exists. The bulbous extremity of the corpus spongiosum is not traversed at all by the urethra, which leaves the spongy body just at the commencement of the bulb. If this is not understood, the handle of the instrument is not depressed sufficiently soon, and if impelled forward the point is liable to be thrust through the lower wall of the urethra. A third mistake is often committed when the point of the catheter reaches the commencement of the membranous urethra. If the handle of the instrument is then depressed too suddenly, its beak is arrested against the front part of the triangular ligament, and if urged onward may penetrate the upper wall of the urethra. Sometimes, even after passing this point, if the handle of the catheter is too forcibly depressed, it is possible to perforate the upper wall of the canal behind the triangular ligament, when the instrument enters the pelvis behind the pubes. These are not imaginary accidents. I have seen them occur; and I have no doubt they have been frequently witnessed by other surgeons. Accordingly, when the catheter in being introduced meets with the least obstruction, instead of applying additional force, it should be withdrawn for a little distance, the point slightly changed in its direction by elevating or depressing the handle of the instrument, and another attempt made to pass it onward. It is seldom that these manœuvres require to be repeated more than once or twice before success is attained and the bladder is safely reached. The merest tyro can, in a healthy urethra, reach the membranous part of the canal; and if any difficulty is encountered between this part and the bladder which is not readily overcome by the instructions already detailed, he has a safe guide in the index finger, which, being introduced into the rectum, will serve to pilot the instrument safely through the remaining portion of the canal.

Occasionally the meatus is preternaturally contracted and refuses admission to the beak of the catheter. The same difficulty may be encountered when there exists a tight phimosis. In either case the proper course (if dilatation cannot be readily effected) is to enlarge the opening by incision. As the catheter enters the bladder, a finger should be slipped over its external orifice, so as to prevent the escape of the urine before the vessel for its reception is properly placed. It will often be found convenient to turn the patient on the side while the urine is being discharged, in which position a

FIG. 1326.



Introduction of the catheter.

chamber or cuspidore can be advantageously used for its collection. After the last drops have escaped, a finger should again be placed on the end of the catheter as it is withdrawn, so that the small amount of fluid which the instrument contains shall not be allowed to escape until its beak has been placed over the urinal.

When it is deemed proper to catheterize in the standing posture, the patient should plant his buttocks against a wall or bed-post, at the same time inclining the body somewhat forward, in order to relax the abdominal muscles. The thighs must also be abducted and slightly flexed, and the feet turned outward. If the patient occupies the sitting position, the nates should rest on the front of the chair-seat, with the limbs widely separated. In both the sitting and the standing posture the surgeon takes his seat directly in front of the patient. The remaining steps of the operation are the same as when the instrument is inserted in the recumbent position.

Some surgeons, fond of investing even the simplest operations with a certain air of display or dramatic effect, introduce the catheter with its convexity upward, and, when the penile portion of the urethra is passed, suddenly impart to the instrument a graceful twirl, by which the curves are reversed, and the handle, after describing a semicircle, sinks down between the thighs. This is the *tour de maître* of the French. I doubt very much the propriety of making a brother man a stage on which to enact a surgical flourish.

In introducing the flexible gum catheter, one which bears no stylet, the manipulation is altogether different from that required by the metal instrument. After oiling its surface, the catheter is grasped near its vesical extremity, which, being inserted into the orifice of the urethra, is pushed onward by short impulses, the instrument never being caught for this purpose at a greater distance than one inch from the meatus.

Every practitioner should have in his possession a number of both metal and gum catheters of assorted sizes. For the purpose of the ordinary practitioner it is entirely unnecessary to purchase the whole series belonging to the different scales, which range from twelve to thirty. Half a dozen of each will meet every requirement.

Retention.—There are circumstances which render it desirable to retain a catheter for some time in the bladder. For this purpose it becomes necessary to secure the instrument by such checks as will prevent its being expelled. A number of contrivances have been devised to accomplish this end. A very simple plan is to pass narrow strips of adhesive or porous plaster through the rings of the catheter, and apply their free ends to the body of the penis. (Fig. 1327.)

Another and very satisfactory method is to apply first a T-bandage to the body, and then fasten the catheter in place by long pieces of tape passed through the rings of the instrument and their ends attached to the perineal strips of the bandage; or an elastic band may be secured to the catheter and made to buckle around the penis.

Mr. Holt has devised what is called a winged catheter. (Fig. 1328.) The

FIG. 1327.



Catheter retained by adhesive plaster.

FIG. 1328.



Holt's winged catheter.

irritation caused by the lateral branches is such that it is not probable this instrument will meet with much favor.

Whenever it is deemed necessary to secure a catheter in the bladder, its

beak must be placed just within the neck of the viscus. If introduced too far, in the event of erection taking place the point of the instrument may damage the inner surface of the bladder. Rarely is any inconvenience experienced from the passage of the catheter. Urethral fever, which is so commonly seen after the use of bougies, is not often witnessed after catheterization. In the female it is exceedingly infrequent. Occasionally in persons of an unusually irritable organization a peculiar, sickening sensation is felt, however delicately the instrument may be managed, which may induce an attack of syncope. I have known a strong man to faint away during this operation, although there was no evidence that any pain was experienced. A knowledge of this fact renders it necessary to be cautious when catheterism is practiced in the standing or sitting position. In the case referred to, the patient was in the erect posture, and fell with considerable force upon the floor, where he lay some time before the effects of the shock passed over.

The portion of the urethra most likely to excite such eccentric phenomena when touched by the instrument is the prostatic.

Catheterization in the Female.—The conditions which produce retention in the female are multiform, and may be described as mechanical, spasmodic, traumatic, paralytic, psychical, and postural.

1st. *Mechanical.*—The mechanical include all causes which, by obstructing the vesical orifice of the bladder, or by compressing its walls, prevent the flow of urine. Thus, a calculus may be washed by the stream of urine into the neck of the bladder and obstruct its canal. A foreign body is sometimes pushed into the same position from without, and, like the stone, acts as a stopper to the mouth of the viscus. A polypus having a long pedicle may do the same. Obstructive pressure may also be exerted by uterine displacements, by the gravid uterus, and by ovarian and other pelvic tumors.

2d. *Spasmodic.*—Spasmodic retention may be produced by any irritant acting on the sphincter muscle of the bladder, such as cold, the absorption of cantharides, hemorrhoids, fissure of the rectum, and abscess of the labia.

3d. *Traumatic retention* is likely to be caused by contusions of the perineum or of the vulva, by pressure of the foetal head in a tardy passage through the inferior strait of the pelvis, and by the blades of the forceps in instrumental delivery.

4th. *Paralysis* of the bladder resulting in retention is often the consequence of cerebral or spinal concussion or compression, fracture of the vertebrae, and over-distention of the organ.

5th. *Psychical.*—Under this head are included all those instances of retention in which, from hysterical or emotional causes, the patient is unable, voluntarily, to empty the bladder.

6th. *Postural.*—Notwithstanding there may be neither organic nor functional disorders of the bladder, females are sometimes unable to discharge the urine in consequence of being compelled to maintain the horizontal position.

Catheterization in the female is to the young practitioner often a very embarrassing operation, as it is proper that the patient shall be subjected to no unnecessary personal exposure.

The female catheter should be metal, six inches in length, eighteen or twenty millimetres in circumference, perfectly smooth, and perforated with

FIG. 1329.



Female catheter.

a number of minute holes near its vesical end (Fig. 1329), which should be well rounded and slightly curved. These openings must not be too large, otherwise the mucous membrane of the bladder or of the urethra is liable

to slip through the perforations and become strangulated, causing great pain in the removal of the instrument, and even wounding the prolapsed membrane.

The most convenient plan of introducing the catheter is for the practitioner, after having first brought the woman close to the edge of the bed, with the limbs drawn up, to take his seat alongside, with his face towards that of the patient. Passing the right or the left hand, according to the side

FIG. 1330.



Position in introducing female catheter.

of the bed from which one operates, under the bedclothing and beneath the thigh of the patient, the top of the index finger, with its palmar surface upward, is placed against the commencement of the upper wall of the vagina, immediately above which can be felt the little eminence which marks the orifice of the urethra. With the other hand the catheter is carried under the clothing in front of the thigh, and its point (concavity upward) conducted along the guiding finger into the canal, and onward into the bladder. (Fig. 1330.) Just before the tube enters the latter a

finger should be placed on its extremity, so as to control the orifice until a cup, cuspidore, or some other convenient vessel is placed in position to receive the urine. When the bladder has been emptied, the finger should again be applied to the end of the catheter, by which means the urine that remains in the instrument will be prevented from spurting out through its eyes until it is placed over the urinal.

When the physician is inexperienced in the use of the catheter, or when his sense of touch is not sufficiently delicate readily to identify the anatomical peculiarities of the parts, I have no hesitation in advising such an exposure as will enable him to perform the operation under the inspection of the eye. Though this is in direct opposition to obstetric teachings, I am quite sure that any lady would be less annoyed, in view of the promptness with which the instrument can be used under these circumstances, than by the delay and blundering manipulation to which she is sometimes subjected when the prescribed order of procedure is followed.

To insert the catheter directed by the eye, the woman may be placed across the bed, on her side, her hips near its edge, with the limbs drawn well up towards the body; the clothing being raised so as to expose the nates, and the labia separated, the instrument can be introduced without the slightest difficulty. The operation may also be done with the patient on the back and the limbs drawn up and separated. The bedclothing can be raised and tucked in round the limbs and along the sides of the perineum, so that nothing but the vulva shall be exposed, when the introduction of the catheter will be the work of a few moments.

Complications in the use of the catheter.—A prolapse of the mucous membrane of the bladder or of the urethra through the perforations in the catheter when these openings are too large has already been mentioned. When such an accident occurs (which may be known by the resistance encountered when an attempt is made to withdraw the tube), the surgeon should endeavor, by pushing the instrument farther inward, and by gentle rotation, to disengage the incarcerated folds. Failing in this, there should be thrown through the cavity of the catheter a quantity of sweet oil, the presence of which will generally facilitate the withdrawal of the tube.

Prolapse of the bladder will produce such a sharp angle at the neck of the organ that, when the viscus becomes distended with urine so that it cannot be replaced, the silver catheter cannot be made safely to pass the bend. In a complication of this kind a soft, flexible, gum instrument must be used.

The urethra and the neck of the bladder may be so long compressed by the foetal head in a tedious labor that catheterization becomes necessary. Under these circumstances, the obstruction to the use of the tube can best be overcome by pushing up the presenting part of the child before inserting the instrument.

Affections of the Spermatic Cord.

The affections to which the spermatic cord is liable are wounds, contusions, inflammations, hydrocele, hæmatocele, and varicocele.

Wounds inflicted over the pubes, or on the abdominal walls above the line of Poupart's ligament, and kicks or blows applied over the same region, necessarily expose the cord to injury. If the spermatic artery is cut or torn, the hemorrhage will be free, and will require the ligature.

Rupture of the vas deferens is said to occur occasionally from falls, forcible abduction of the limbs, etc. The signs which have been described as accompanying the accident are deep-seated pain in the inguinal canal, following a feeling of something having given way in the groin, swelling of the testicle, and a discharge of arterial blood from the urethra.

Mr. Hilton mentions three cases of this injury, which have been published by Holmes. As the blood which was discharged from the urethra was proven not to have come from the bladder, the catheter, when passed into this viscus, evacuating only clear urine, it was inferred that its true source was the deferential artery, and that it had passed along the vas deferens to the common ejaculatory duct and by this route reached the prostatic part of the urethra. In all of Mr. Hilton's cases the accident was followed by wasting of the testicle. As this injury has never been verified by dissection, and as it is difficult to conceive how the duct could have been seriously affected by the causes which are assigned for its rupture, the reality of the accident may be questioned.

If the vas deferens should be severed, even though its ends were apposed and retained by the introduction of fine silk sutures through the investing cellular tissue, there would be little probability of again establishing the continuity of the seminal channels; though, if the wound was an open one and the cord exposed, the attempt might be made.

When the entire cord is divided, after securing the spermatic artery and stitching the ends of the vas deferens, the other constituents should be brought together by a few interrupted sutures. If the external opening is not large enough to admit of a free access to the cord, it must be enlarged. During the late American war there were five cases of wounds of the spermatic cord, in three of which the spermatic artery was tied. The cord was completely severed in three of the five cases. Ligature of the spermatic artery is a very rare operation. It has been done by Professor Hecker, by Beck, and by Malgaigne.

Atrophy of the testicle has been observed to follow these wounds of the cord, and in one of the cases reported during the late war the patient was left impotent.

Inflammation of the spermatic cord is rare as a primary affection. It may succeed an attack of acute orchitis, epididymitis, or a suppressed urethritis. It is sometimes seen to accompany malignant diseases of the testes.

The signs of the inflammation are swelling, induration, great tenderness, and a sense of dragging weight experienced in the course of the inguinal canal. The inflammation is sometimes accompanied by severe constitutional disturbance. Inflammation of the cord terminates in resolution, rarely in suppuration.

TREATMENT.—When the inflammation is a sequence of a contiguous inflammation (as of orchitis or epididymitis), the removal of the latter will be followed by the subsidence of the disease in the cord. If not, or if it supervenes on the reception of a contusion, it will be necessary to apply the remedies directly over the cord.

The hair being removed, a few leeches may be applied above the pubes, a lotion of lead-water and laudanum laid over the parts, and the testicle sufficiently well supported to relieve the cord of any drag or weight. Should the inflammation terminate in abscess,—a very rare occurrence,—the pus will require to be evacuated by an incision.

Fatty tumors of the cord are quite common. There is a considerable amount of adipose tissue existing along the cord as a normal condition. It is sometimes massed in the connective tissue at a single point in the cord, either below or above the external abdominal ring, or it may constitute a long roll, with one or several constrictions. I have examined cases of fatty spermatic cord which had been confounded with hernia. The doughy feel of the growth might readily cause it to be mistaken for a mass of omentum. Its fixed position and the absence of impulse to the enlargement during coughing will be sufficient to correct any misapprehension on this point.

In most instances these fatty growths are altogether harmless, and require no surgical treatment. When observed to increase gradually in size and when situated above the external ring, they may be atrophied by wearing a truss, the pad of which is placed directly over the growth. Only when the tumor becomes inconvenient or troublesome from its size will extirpation be necessary. In performing this, the greatest care must be taken not to wound the components of the cord. It is possible for the growth to be so completely interwoven with the different parts of the latter as to require the extirpation of cord and testicle. A case of this kind, demanding this radical procedure, was operated on by Mr. Lawrence. The tumor measured eight inches in length by six in breadth. A sarcoma subsequently appeared at the seat of the first excision. This is occasionally witnessed after the removal of fatty tumors, and has led to the erroneous idea that such growths are recurrent. Operations were subsequently performed by Mr. Curling at different times for the removal of sarcomatous tumors from the original site of the first, the last being done at a period of twenty years from the primary operation. The man finally died, fifteen weeks after the last excision.

Carcinoma of the spermatic cord is seldom witnessed. Curling records two cases, one of which came under the observation of Hunter, and the other was removed by Mr. Spence, of Edinburgh. There was no doubt entertained in either of these cases that the disease, which was of the medullary variety of cancer, commenced primarily in the cord. In the one described by Hunter, the omentum and lumbar glands were also affected. Little can be gained by an operation in such cases, as the disease must inevitably return. The operation of Mr. Spence was followed by death, sloughing and peritonitis setting in after the excision.

Spasmodic retraction of the cord is a common effect of the passage of a stone, or of crystals of uric acid or of oxalate of lime, along the ureter. It may attend almost every irritation seated in the kidney, urethra, or sexual apparatus. It is sometimes seen in young persons possessed of an irritable nervous system. It is produced by the irritation being communicated to the cremaster muscle through the agency of branches of nerves distributed to the cord. The testicle during the spasm is drawn up towards the external abdominal ring. Twice have I seen in young lads the testes retracted into the canal.

The *treatment* is either palliative or radical. When the spasm is attended with pain, a hot hip-bath or a fomentation of hot water to the parts will secure its resolution. Should this fail, a hypodermic injection of morphia, or morphia and belladonna by the mouth, may be administered.

Permanent relief can be obtained only by searching for the cause, and, as far as possible, removing it by appropriate treatment. When it is the result of general nervous irritability in young persons, a careful inquiry should be made into their private habits. In many of these cases iron and belladonna and camphor will exert a good effect.

Syphilitic enlargement of the spermatic cord is occasionally seen among the later manifestations of this disease, though usually in connection with a similar state of the testicle.

It must be treated by the use of those remedies which are employed for constitutional syphilis.

Hydrocele of the spermatic cord may occur under three different forms,—*diffused*, *encysted*, and *congenital*, or what I prefer to call the *abdomino-inguinal*.

This subject will be better understood if we recur for a moment to one or two anatomical and physiological facts.

The testicle, in its descent from the lumbar region to the scrotum, carries with it a duplication or double layer of the peritoneum. There consequently exists a prolongation of this serous sac, from the internal abdominal ring to the bottom of the scrotum, one layer of which lies in contact with the cord and the tunica albuginea of the testicle, and the other with the inner surface of the cremaster muscle and the scrotum. There is, therefore, a space more or less complete between these two laminae. Ordinarily the two layers of this funicular process become blended into one, above the external ring, cutting off all communication between that part below containing the testicle, which remains open, and that part above, where it closely invests the cord.

If, however, the two layers above become blended at the internal and external rings, the intermediate portion remaining separate, and a collection of serum should take place, they form an oblong swelling, or a *diffused hydrocele of the cord*.

Again, this tubular tunic of the cord may contract at one or more places in the course of the cord, the intermediate portions remaining unclosed, thus converting the membrane into a number of closed sacs; if, in this condition, a collection of serum should occupy one or more of these compartments, it will constitute an *encysted hydrocele of the cord*.

Lastly, when the contraction of the two layers of the tubular process of peritoneum occurs round the cord only at or near the external ring, leaving the remaining portion above unclosed and, of course, communicating with the cavity of the peritoneum above, there exists a condition which, when this tubular canal becomes filled with serum, answers to what is designated as *congenital hydrocele*.

As all of these forms of hydrocele belong chiefly to children, and are found in both sexes, it will only be necessary to substitute the round ligament in the female for the spermatic cord in the male in order to render them intelligible in the former sex.

Diffused Hydrocele of the cord consists of a collection of serous fluid within the unobliterated portion of the tunica vaginalis of the cord, forming an elongated cylindrical or ovoidal swelling, which becomes somewhat pyriform in the erect position by the gravitation of the fluid. This swelling may extend from a short distance above the testicle to the internal ring (Fig. 1331), and is covered in by the cremaster, the transversalis fascia, the aponeurosis of the external oblique muscle, and the abdominal integument. The accumulation may vary in size from the thickness of the little finger to the bulk of an egg.

FIG. 1331.



Diffused hydrocele of the cord.

The swelling is soft, compressible, and fluctuating, and when any portion which appears below the external ring is pressed upon by the finger, the contents will recede into the inguinal canal, to reappear on removal of the pressure. When the collection is large and the overlying layers of tissue are somewhat attenuated, translucency may be recognized by a proper use of the light test. The description which has been given of this form of hydrocele by Pott is, in my opinion, entirely at variance with both the anatomical and the physiological structure of the cord and its tunic, answering better for œdema than for hydrocele.

DIAGNOSIS.—Diffused hydrocele may be confounded with omental hernia, encysted hydrocele, and lipoma. The following distinguishing characteristics between this affection and omental hernia will aid in the diagnosis:

DIFFUSED HYDROCELE.

No impulse communicated to the swelling on coughing.
Irreducible nature of the swelling by pressure.
Gradual reappearance of the swelling after being diffused by pressure.
Fluctuation on manipulation.

OMENTAL HERNIA.

Impulse communicated on coughing.
Reducible by taxis, if of the reducible variety.
Sudden and forcible descent of the omentum on coughing after reduction.
Doughy feel on pressure.

If the omental hernia should be irreducible, the obscurity will be very embarrassing, even to the most experienced surgeon, but may generally be cleared up by the exploring needle, which, in the case of hydrocele, would exhibit the characteristic fluid. Even with this sign a false conclusion might be reached, as the sac of an omental hernia may contain a similar fluid.

TREATMENT.—Small collections of fluid require no interference. When, however, the accumulation is observed steadily to increase, its absorption may first be attempted by introducing a fine-bladed tenotome into the sac and scratching its interior at several points, following the scarification by the pressure of a truss, or by a compress and spica roller. Should this method fail, one or two fine silk threads may be deposited as a seton in the sac, and be allowed to remain thirty-six hours, pressure being made over the swelling after their removal. These threads can be made more effective by soaking them in the tincture of iodine previous to their introduction.

Finally, as a last resort, the fluid may be drawn off by a fine trocar, and the tincture of iodine injected into the sac through the canula.

FIG. 1332.



Encysted hydrocele of the cord.

Encysted Hydrocele of the cord appears as a circumscribed swelling in the course of the cord, of an oval form, and rarely exceeding a walnut in size. It may occur below the external abdominal ring or within the inguinal canal, and projects chiefly in front of the cord. There may be one or several of these cysts (Fig. 1332). They usually contain a straw-colored fluid, coagulable on the application of heat. Spermatozoa are said to have been found in this liquid, which could only occur by some communication between the cyst and the vas deferens, or with the epididymis below.

Giraldis, of Paris, has described a structure in the spermatic cord of infants, consisting of vesicles and contorted tubes, which he regards as the remains of the Wolffian body, and which he believes to be the source of the encysted hydrocele.

DIAGNOSIS.—The liability to mistake encysted hydrocele for hernia exists, as in the diffused form, especially when the serous collection is within the canal; yet by noticing the absence of impulse, gurgling, and resonance, and

the constancy of the swelling, even in the recumbent position, with the impossibility of forcing the tumor either into the abdomen or out through the external ring (peculiarities which belong to hydrocele), a reasonable degree of certainty may be obtained as to the nature of the disease.

When an encysted hydrocele is below the external ring, the diagnosis is less difficult. The tumor will be well defined, have a uniform shape, be translucent, and be free from impulse on coughing.

TREATMENT.—Encysted hydrocele often requires no treatment whatever, as it will frequently disappear spontaneously. The parts over the swelling may be painted with Lugol's solution of iodine or with a strong solution of muriate of ammonia, or an ointment of iodoform may be rubbed into the tumor. The pressure of the pad of a truss will, as in the diffused form of the disease, often cause the absorption of the serum. When the swelling exhibits a tendency to increase, one or two threads, soaked in tincture of iodine, may be introduced into the sac, and allowed to remain for twenty-four or thirty-six hours; or twenty or thirty drops of tincture of iodine may be injected into the tumor, after draining off the fluid by the trocar and canula.

Congenital Hydrocele of the spermatic cord is a rare affection. When it exists, the funicular process is closely adherent to the cord at the external ring, but remains open above, and communicates with the abdomen.

It must not be supposed, however, that the communication with the abdomen is always free; in other words, that the cord lies loose in its funicular tunic. If this were the case, a portion of the intestine or omentum would descend as readily as serum, and we should have hydrocele and hernia at the same time. This does occasionally occur, but it is not common. The investing prolongation of the peritoneum adheres sufficiently close in most instances to the cord to allow only of the accumulation of the fluid which constitutes the hydrocele.

The symptoms of congenital hydrocele of the cord are a soft, fluctuating swelling in the canal, markedly increased when the patient stands erect, and diminished when he assumes the recumbent position. By pressure on the swelling, when the body is in the latter posture, the tumor can be made to disappear, the fluid being forced back into the cavity of the peritoneum, to reappear quite slowly when the patient gets upon his feet. Coughing also communicates an impulse to this variety of hydrocele.

The alternate increase and diminution of the tumor, according as the standing or the horizontal position is assumed, and the presence of a slight impulse during forcible straining or coughing, cause this hydrocele strongly to resemble hernia.

In hernia, however, the tumor recedes suddenly and completely upon taxis, its retrocession being often attended with a distinct, *gurgling* sound; and when it reappears under the succussion imparted by coughing, it starts out suddenly into the canal. These characteristic signs are in striking contrast with the tardy disappearance and reappearance of congenital hydrocele under similar conditions. To these differences may be added the sign of translucency always present in uncomplicated hydrocele, when the tumor is sufficiently large to allow the application of the light test. Any of the preceding forms of hydrocele of the spermatic cord may be conjoined with a hydrocele of the tunica vaginalis testis.

TREATMENT.—The proper plan of treatment is to apply a truss, which, by compressing the sides of the canal together, favors the closure of the funicular process at the internal ring.

Hæmatocele of the spermatic cord, like hydrocele, may be either *diffused* or *encysted*.

Diffused hæmatocele is produced by rupture of one of the spermatic veins, in consequence of external violence or during some unusual straining efforts. In one instance mentioned by Maunder the accident occurred during con-

nection. These veins being inclosed within the funicular sheath, the blood in case of their rupture extravasates into the connective tissue of the cord, passing upward and downward in the direction of the rings, and even descending as low as the testicle.

The symptoms resemble those of hydrocele in the location of the swelling, but differ from the latter in that the blood tumor appears suddenly and generally after some extraordinary muscular effort or some external injury, and in the latter event is accompanied by discoloration or ecchymosis of the groin and scrotum.

In one case, that of Mr. Freke, the swelling of a hæmatocele was mistaken for hernia, and the parts were laid open. Mr. Bowman* mentions a case of hæmatocele in which the tumor eventually extended to the knee (Fig. 1333), and which finally proved fatal by hemorrhage and by hectic fever consequent on destructive changes in the enlarged mass.



Bowman's case of hæmatocele.

Encysted hæmatocele of the spermatic cord is exceedingly rare. I have never seen an instance of the disease. There is every reason to believe that when it does occur it is generally a complication of encysted hydrocele of the cord; a spermatic vein having given way, so as to allow its blood to mingle with the serum of the sac, forming a mass of loose, dark clots or slightly stratified coagulations. These may remain for a long time unchanged, becoming gradually absorbed, or they may cause sufficient irritation to produce suppuration. The tests for diagnosing hydrocele of the cord from hernia may be applied in establishing a distinction between rupture and hæmatocele, but between the latter and hydrocele the grooved needle alone can determine the difference.

TREATMENT.—Rest in the recumbent position and the local application of cold are the remedies indicated in a case of hæmatocele. These may be supplemented, if not sufficient to control the hemorrhage, by a thick compress laid over the course of the inguinal canal and firmly secured by a spica roller on the groin. In the event of extreme measures becoming necessary from the continuation of the bleeding, the cord should be uncovered by dividing the integuments and the aponeurosis of the external oblique muscle of the abdomen, and tying the vessel or vessels at fault. There can scarcely ever be a necessity for castration in such a case, though this operation was done in one instance by Pott.

Varicocele is a term used to designate a dilated, elongated, and tortuous condition of the spermatic and pampiniform veins of the cord. (Fig. 1334.) The condition is sometimes termed *circocoele*. The disease is quite common in early manhood, from fifteen to thirty-five years of age, and is rarely seen under puberty.

From the absence of a valve in the left spermatic vein at the point of its entrance into the corresponding renal vein (a fact first pointed out by Dr. John Brinton, of Philadelphia), varicocele almost invariably occurs on the left side.† The same condition is seen in the veins of the left ovary of the female.

To this may be added, as having also some determining influence, the retortangular relation of the two veins, spermatic and emulgent, at their junction, the superincumbent position of the sigmoid flexure of the colon, and the

* Curling, *Medico-Chirurgical Transactions*, vol. xxxiii. p. 233.

† There is great irregularity in the presence and the position of the valves of the spermatic vein.

greater length of the left spermatic vein. Occasionally, however, varicocele is met with on the right side, and sometimes on both sides.

Landouzy, in his work on varicocele, states that of 5639 army recruits rejected on account of that disease, 4881 were affected on the left side, 344 on the right, and 414 on both sides. The frequency of double and of right-side varicocele mentioned by this author will, I think, strike any one as remarkable. Though I examined a large number of recruits during the late American war, I did not witness a single instance of right-sided varicocele.

Marshall states that in 30,000 recruits examined by him, no case of well-marked varicocele was observed on the right side. Sir Astley Cooper never saw the disease on the right side; and of the 120 operations performed by Breschet for the cure of varicocele, only one was done on the right side. This disease is estimated by Humphry as occurring once in every ten males.

Of 166,317 recruits inspected in the districts of Great Britain and Ireland during ten years ending March 31, 1853, 55,474 were rejected; of the latter number, 3911, or 70.5 per 1000, were rejected for varicocele.* Of 2,165,470 recruits examined in France in ten years, from 1850 to 1860, 20,553, or 10.05 per 1000, were exempted for varicocele. A proportion considerably greater will be found to exist in the United States.

CAUSES.—The great length of the spermatic veins, their tortuous course, the irregularity in the presence and position of their valves, the pressure likely to ensue from fecal accumulations in the sigmoid flexure of the bowel, any relaxed condition of the abdominal or cremaster muscles, all contribute to embarrass the circulation through these venous channels, and thus favor the production of the dilatation. I do not think that the disease can be often traced to family peculiarities, as it is rare to see more than a single case in the same family, and the coincidence of father and son being both subjects of varicocele is not common.

In addition to these structural or determining causes there are a number of exciting ones, under which head may be included all that in any way tend to determine an unusual amount of blood to the testicles, as heavy lifting when the body is in a stooping position, straining efforts in defecation on account of constipation, excessive venereal indulgence, bareback riding, and a preternatural redundancy of the scrotum.

The marching, fatigue, and exposure incident to the life of a soldier must exert a considerable influence in producing the disease, as we find that in the monthly reports of the sick and wounded during the late American war there are recorded 7270 cases of varicocele.

SYMPTOMS.—Varicocele may exist without causing any particular uneasiness, physical or mental. It is gradually developed, and generally, as it progresses, there are experienced a sense of weight and a dull, aching pain extending along the cord and to the small of the back. As the veins increase in size they form a soft, doughy, convoluted, and elongated mass, not inaptly compared to a bunch of cords or of earth-worms, and extending from the

FIG. 1334.



Varicocele veins.

* Curling on the Testes, p. 527.

lower part of the scrotum up towards the external abdominal ring. The scrotum, in consequence of the additional weight which it is compelled to sustain, becomes relaxed and elongated, the color of the blood in the veins being quite visible through its walls.

In many persons the disease exerts a very depressing effect on the mind, fears being entertained that the virility of the parts will be damaged by the enlargement.

The structural changes which occur in bad cases of varicocele affect both the spermatic veins and the testicles. The veins at some points are very much thickened by inflammatory infiltration of their walls, imparting a knotty appearance, while at others their coats are markedly attenuated. Phlebolites are occasionally observed in the cavities of these vessels. The sluggishness of this circulation in the venous trunks necessarily deprives the testicles of that free interchange of blood which is essential to their proper nutrition; consequently the testis of the affected side becomes soft, and frequently atrophies to a greater or less extent.

DIAGNOSIS.—The diseases with which varicocele is often confounded are scrotal hernia and congenital hydrocele. The points in which scrotal hernia and varicocele resemble each other are the following: both produce enlargements in the scrotum; both commence above and descend; presuming the hernia to be reducible, both disappear in the recumbent and reappear in the erect position; and in both there is an impulse communicated to the hand on coughing.

The feel of a mass of tortuous, convoluted veins is very unlike that obtained from the uniform surface of either an intestine or omentum. The crucial differential test, however, is both simple and decisive. Let the patient take the horizontal position, when, upon compressing the scrotum, the swelling will disappear. Let a finger be now placed over the external abdominal ring and the patient be requested to rise to his feet. If the case is one of hernia there will be no return of the tumor; but if the disease is varicocele it will quickly reappear, as the finger, which, in the first case, occludes the only opening through which the rupture can escape, in the last case, by pressing the spermatic veins, prevents the blood from returning into the abdomen, and thus causes their trunks below to become distended.

In view of so simple a test for establishing a correct diagnosis, it seems inexcusable in a physician to commit the blunder which is very common, of placing a truss on a patient with varicocele, under the impression that the swelling is due to hernia.

In congenital hydrocele there are the same recedence of the swelling in the recumbent and the same reappearance in the erect position as characterize varicocele; but the translucency of the former, when tried by the test of light, is sufficient to remove any doubt as to the nature of the tumor.

TREATMENT.—In many cases of varicocele, especially in persons of mature life, the disease remains stationary, or makes such slight progress as to demand little, if any, attention. When, however, the veins acquire a bulk which creates an uncomfortable sense of dragging weight, or burning pain, there are several measures for affording relief and preventing an increase of the disease.

Whatever will impart tone to and stimulate contractility in the dartos and cremaster muscles will contribute much to palliate the symptoms.

With this object in view, the parts should be dashed two or three times a day with cold water, or they may be switched as often with a wet towel. A light beating of the scrotum with a piece of rubber tubing for twelve or fifteen minutes every day has also an excellent effect in causing the scrotum to contract. An accurately fitting suspensory bag must be worn,—one which will keep the parts well drawn up; and, in addition to these measures, the bowels must be kept regular, all excessive exercise avoided, particularly during warm weather, and all heavy lifting abstained from. The use of ergot internally continued for several weeks will also contribute to the contractility.

of both the vein and the scrotum. When the ordinary supporting band does not give sufficient relief, the suspending one of Mr. Morgan, of Dublin, can be substituted with great advantage. (Fig. 1335.) This consists of a piece of webbing, cut so as to conform to the shape of the affected side of the scrotum, and supplied with a tongue of chamois leather, a lacer, and two suspenders. The lower end of the bag has a lead wire sewed in its hem, which aids in keeping the sling in place and offering a fixed point of support. The affected testicle and its scrotum are elevated, so as to empty the veins of their blood, and then placed within the bag and retained by the lacer bringing its sides together. The suspenders are next buckled into a bandage or band surrounding the body. By this ingenious plan the bottom of the scrotum is turned upward, a position most favorable for emptying the veins. The same end can be attained, though less satisfactorily, by encircling the affected side with adhesive strips, while the scrotum is kept raised, after which the suspension can be effected by a loop of plaster placed vertically over the opposite sides of the circular strips, through which loop a strip of bandage can be passed, and its ends tied to a band worn round the abdomen. (Fig. 1336.) Mr. Wormald attempted to supply the needed support by drawing the redundant tissues at the lower end of the scrotum through a metal ring of soft silver wire lined with chamois, until the testicles and veins were crowded up against the pubes, when the sides of the ring were pressed together with sufficient firmness to retain the instrument in place. This plan is not altogether free from danger, as the included tissues have been known to slough from the pressure to which they were subjected. Independently of this, the appliance is worn with considerable discomfort to the patient.

Pressure of the spermatic veins in the external abdominal ring has been followed in some instances with very satisfactory results. At first sight this plan would seem rather calculated to aggravate the difficulty, by the impediment placed in the way of the blood returning from the dilated vessels into the abdomen. This is really the case so far as the affected veins are concerned, but the object is to direct the blood back by other and smaller channels, and thus take off the weight from the diseased ones. The best plan of applying this compression is by a truss having a ring with a small central pad, which will fit into the external abdominal ring or between the pillars of the tendon of the external oblique muscle. (Fig. 1337.)

There are cases of varicocele where, in consequence of the physical inconvenience experienced and the disturbed mental condition of the patient, disqualifying him from any pursuit and making his life miserable, the question of operation must be considered. On this subject there is considerable diversity of opinion among surgical writers. Often this morbid state of the mind, which also leads its victims to magnify the local suffering, is the result of ignorance of the nature of the disease, or has been developed by injudicious counsel of friends; and, where this is the case, a few words of explanation

FIG. 1335.



Morgan's suspensory bandage or sling applied.

FIG. 1336.



Suspensory of adhesive plaster.

FIG. 1337.



Pad for varicocele.

and encouragement from the physician will restore mental quietude. If this cannot be done, there remains only one course to be pursued, and that is, to attempt an obliteration of the veins by an operation. I say attempt, for it is very rarely that this can be done perfectly. What, therefore, is called the radical cure of varicocele must be accepted in a restricted sense, as in most instances it will be partial, though sufficient to leave the patient in a much better condition, mentally and physically, than before its performance.

Subcutaneous ligature of the spermatic veins, first tested by M. Davat on animals, is an operation free from danger, and one which I have practiced for twenty years without having witnessed, in a single case, any alarming symptoms. The steps of the operation, after the etherization of the patient, consist first in removing the hair from the scrotum, after which the cord is grasped between the thumb and the index and middle fingers, about one inch below the external abdominal ring, and slid backward and forward, until the vas deferens is discovered and slipped behind the remaining constituents of the cord. This duct, by its hard, wire-like feel, is readily recognized, and, as it is pressed back, the artery with which it is closely associated accompanies it. If the manipulation has been successful, the veins are now in front of the grasp of the thumb and index finger, and the vas deferens and artery are behind it. A stout acupuncture-needle should now be thrust through the cord, between the veins and the duct. A needle, armed with a double hempen thread well waxed, is then entered at one of the perforations made by the pin, passed in front of the veins, between the latter and the skin, and made to emerge at the other perforation of the pin. The operation is completed by slipping the loop of the double ligature over one end of the pin and tying its free ends over the other, during the tightening of which both extremities of the thread slip within the integument and become strictly subcutaneous (Fig. 1338). A cork can now be placed over the sharp end of the pin, and the scrotum kept elevated by a small cushion.

FIG. 1338.



Scrotum laid open to show the subcutaneous ligature of the spermatic veins; vas deferens behind the pin.

The patient must remain in bed for eight days and use a moderately spare diet. On the seventh day the ligature is to be removed, which is readily accomplished by withdrawing the pin.

By this plan the thread can be detached at any time without waiting for it to exit through the included vessels. After the pin and ligature have been taken away, the patient should remain in bed for another day, when he may be allowed to rise; but he should continue to wear for two or three weeks a suspensory bandage.

A great number of operations of a somewhat similar nature have been employed by different surgeons, none of which, however, has any advantage either in simplicity of execution or in permanency of results.

The earliest procedure of the kind consisted in thrusting through the scrotum a pin, between the vas deferens and the dilated vessels, and then passing a thread, in the form of the figure 8, over its extremities and drawing it sufficiently tight to strangulate the varicose vessels. This operation, which was practiced for some time by prominent French and English surgeons, among them Velpeau and Fergusson, was improved by Mr. Lee, who used two pins instead of one, leaving a space between them of about one inch, thus rendering the ligature of all the diseased veins more certain. On the third day following he divided the veins subcutaneously, or between the two ligatures.

Curling, after ligating according to the above plan, introduces a delicate tenotome flatwise beneath the veins, and, turning its edge forward, divides the vessels between the two pins at the time of the operation.

Vidal, after passing a silver pin between the veins and the vas deferens, carried a needle, bearing a silver thread, through the openings made by the pin, but between the integument and the affected vessels, and constricted the latter by first twisting the silver wire round the end of the pin and afterwards turning the pin on its axis, thus rolling the veins round its shaft.

Ricord's method consists in passing two double ligatures in opposite directions, but through the same holes, one between the veins and the vas deferens and the other between the veins and the skin; the free ends of each double thread are next passed through the loops of its fellow-ligature, when, by making a sufficient amount of traction, the strangulation is effected.

Wood's plan is to use subcutaneously a wire for embracing the veins, which is tightened by a spring, to which the ends of the metallic thread are fastened.

Sir Astley Cooper recommended and practiced excision of a portion of the redundant scrotum for the relief of varicocele, and more recently the same procedure has been advocated by Henry, of New York; but the operation has met with little favor. Aside from the probability of the integument becoming again elongated, there is considerable risk of concealed hemorrhage occurring between it and the tunica vaginalis, unless very great care has been taken to secure the vessels.

This accident is rendered less likely to occur by using the clamp of Henry, or by repeated transfixion of the scrotum by means of a long acupressure-pin, as advised by Hutchison, of Brooklyn.

Castration and excision of the veins have been resorted to in bad cases of varicocele, but no surgeon at the present time would doubt for a moment the impropriety of such operations. A modified form of excision has been advised by Annandale, in which, after cutting out a portion of the principal vein, the bleeding is controlled by acupressure.

A question of some moment in connection with operative procedures for the obliteration of varicose spermatic veins is, What is their effect on the testicle? Are such operations followed by atrophy of the glands? I have never seen any such change, and I think this accords with the experience of surgeons in general. Were the chief artery included in the ligature, such an effect might be anticipated; but, as I have stated, this vessel, by its contiguity to the vas deferens, escapes injury. The celebrated French surgeon Delpech was assassinated by a man whose spermatic veins he had tied for the cure of a varicocele, on account, as was represented by the criminal, of the testicles having become atrophied after the operation.

The dangers to which an individual is exposed who may be in ill health at the time of the operation for varicocele are phlebitis, erysipelas, and pyæmia.

Anomalies of the vas deferens are of different kinds. The duct may terminate in a blind pouch contiguous to the testicle, or it may have no connection either with the testicle or with the seminal vesicles. This was the condition in Dr. Turner's case.* Brugnone notes one instance in which the duct and the epididymis were both absent.

Affections of the Testicle and its Tunics.

Absence of the Testicles.—A number of cases of this nature have been recorded by writers, particularly by the French. Many of these were, perhaps, examples of atrophy, or of undescended testicle, rather than of congenital absence. This atrophy is liable to occur both before and after birth. There are, however, a number of well-established instances in which one or both testes have been entirely wanting. Most of these have been collected by

* Curling on the Testes, p. 7.

Goddard.* When one of the testes is not present, the term *monorchid* is used to express the condition. When both glands are absent, the term *cryptorchid* is employed.

Sometimes there is only a partial absence of the testes,—that is, the scrotum may contain only the epididymis, with or without the vas deferens; at other times the vas deferens alone is present.

Supernumerary testicles have been mentioned by Schaarf, Blegney, Blasius, and others. The first-named writer describes a man who was believed to have five, and the person whose case is recorded by Blegney is represented to have possessed four glands. Twice have I seen the globus major so detached from the body of the epididymis as to resemble strikingly a third testicle. As no dissections, so far as I know, have been made with a view to verify the existence of supernumerary testicles, the genuineness of the cases reported may very well be doubted, the body supposed to be the testis having possibly been a cyst, a hernia, or a tumor of some kind.

Anomalies of position.—The absence of one or both testes from the scrotum is no evidence that these organs do not exist. Frequently they remain undescended, either in the abdomen or in some portion of the inguinal canal. When in the latter situation they are liable to be mistaken for hernia, and are indeed sometimes associated with that affection.

The testicles at birth frequently fail to make the complete descent of the canal into the scrotum. They may remain in the abdomen, below the kidney, in the inguinal canal, or just external to the external abdominal ring. The left testis remains undescended more frequently than the right. This defect is quite common.

Weisberg, in an examination of 103 infants, found 21 in whom one or both testicles were immediately external to the abdominal ring, and in 12 one or both were in the abdomen. Sometimes in the descent the testicle goes astray, and, instead of following the inguinal canal, passes into the femoral canal, and appears through the saphenous opening on the front of the thigh.

In several instances the testicle has been lodged in the perineum. It is difficult to conceive how the gland could reach this locality except by a continuity of the integuments of the perineum with those at the external abdominal ring. Mr. Curling, who has seen eight cases of the kind, explains the anomaly by assuming the attachment of the middle part of the gubernaculum to the integuments of the perineum. Similar displacements have been witnessed by Hunter, Goddard, Vidal, Ledwich, Adams, Bryant, and myself.

If the descent is not completed before puberty it rarely occurs subsequently. In many cases it takes place about the period of birth.

I have in two instances witnessed the gland undergo singular changes in position, one day being in the scrotum, and the next in the inguinal canal, having been retracted by the cremaster muscle. Should the complete descent be delayed longer than eight or ten months after birth, it is liable to be accompanied by a hernial protrusion. Where the testicle is permanently detained in its unnatural position, it generally remains undeveloped, the tubuli seminiferi being defective and their secretion devoid of spermatozoa. This does not necessarily compromise either the fruitfulness or the vigor of the genital organs. The deficiency is usually provided for by an increased enlargement of the other or normally-placed testis.

Previous to a microscopic examination of the seminal fluid, it would be unsafe to pronounce positively as to the barrenness of an individual in whom both testicles have failed to reach the scrotum. If, upon such an inspection, the semen is found devoid of spermatozoa, it will establish the fact of sterility, though not necessarily of impotency. A retained testicle must be regarded as an unfortunate circumstance, as the gland is liable to disease, occasionally of a malignant nature, especially when it remains in the inguinal canal. In this situation it is exposed to severe compression during the many

* Gazette Médicale de Paris, 1860, pp. 217, 435.

powerful contractions of the abdominal muscles, in consequence of which it may be attacked by neuralgia or by inflammation, the disease extending to the peritoneum and destroying the patient. It will also predispose to hernia. In some instances, where the testicle has passed from the abdomen through the internal ring into the inguinal canal, in making ineffectual efforts to descend it has, in consequence of the incarceration to which it was subjected, given rise to symptoms which closely simulated strangulated hernia, as pain, abdominal distention, and vomiting.

DIAGNOSIS.—The occasional descent of a retained testicle, its appearance external to the abdominal ring, and its subsequent spontaneous retraction, or its retrocession either by recumbency or by pressure, are signs belonging to inguinal hernia, with which it might be confounded. But when the untenantated scrotum, the peculiar ovoidal form of the tumor, its firmness, and the sickening sensation caused when it is compressed, together with the absence of impulse in coughing, are considered (none of which signs belong to rupture), there will be little difficulty in reaching a correct conclusion. Instances have occurred, however, in which the diagnosis has been rendered exceedingly embarrassing in consequence of the swelling following an inflamed undescended testicle having reached the scrotum before surgical aid was sought, and in which it was impossible by feeling to ascertain whether the testicle was in its proper position.

Just such a complication came under the observation of Pott, who was called to see a patient supposed to be suffering with strangulated hernia. In the hands of a less careful surgeon an operation would doubtless have been performed.

I operated on a boy about sixteen years of age, who had a strangulated hernia following an undescended testicle. On opening the canal, both the intestine and the testicle were found, the latter quite normal in size and appearance. The stricture was divided, the bowel returned, and the testicle brought down into the scrotum without difficulty. The boy made a rapid recovery. Whether, after returning to his occupation, which was that of a plumber, the gland remained in the scrotum or not I am unable to say, as he passed out of my observation.

When the testicle is placed in front of the thigh or in the groin it may be confounded with bubo, and I know of two such instances in which it narrowly escaped being punctured, under the supposition of its being a suppurating gland. If the scrotum on the affected side is found empty it is not probable that any mistake will be committed.

The causes which operate to prevent the descent of the testicle are not always obvious. Among those which have been assigned are adhesions, either within the abdomen or within the inguinal canal, some defect in the contracting property of the gubernaculum testis, or in the capacity of the inguinal canal, and preternatural shortness of one or more of the constituents of the cord.

TREATMENT.—As long as the gland remains high up in the inguinal canal, and occasions neither inconvenience nor suffering, there can be no necessity for any interference. When it is encountered below the external ring, an effort may be made to coax or constrain its descent. This is done by gently dragging it downward, and, to prevent its retrocession into the canal, by guarding the ring with a truss having a soft pad. Should a hernia follow the testicle, and the latter can be detected external to the canal, the truss will answer the double purpose of retaining the rupture and preventing the retraction of the gland.

When the testicle is subject to violent retraction, producing severe distress, it is not improbable that, by exposing the cord and dividing the fibres of the cremaster muscle, relief might be obtained and the descent of the organ be favored.

Operations have been performed with a view to placing the testicle in the scrotum by Partridge, by Curling, and by Adams, but without success, as the

attempts (which consisted in dividing such adhesions as were thought to check the descent) were followed by the death of the patients. It is somewhat singular that in none of these operations did it occur to the surgeon to divide the cremaster muscle. If the testis follows the femoral canal and appears in front of the thigh, it is best, if possible, to press it back through the saphenous opening into the abdomen, applying a truss to prevent its return. Should the abnormally-placed testicle be productive of repeated attacks of pain or other distress, the welfare of the patient will be best consulted by extirpating the gland. Other displacements of the testicle have been noticed, in which the epididymis is attached to the anterior instead of the posterior part of the testis (*inversion of the testicle*), or in which the gland is reversed with the vas deferens arising from the small end of the epididymis.

Hydrocele.

Hydrocele consists in an abnormal accumulation of fluid in the cavity of the tunica vaginalis testis. It is an exceedingly common affection, occurs with about equal frequency on both sides, and is occasionally met with simultaneously in both vaginal tunics. Hydrocele may be either *congenital* or *acquired*. It is also *unilocular*, when the fluid is contained in the common cavity of the tunica vaginalis; *bilocular*, when that cavity is divided into two sacs by adhesion of a portion of its walls; and *encysted*, when the fluid is in a sac independent of the tunica vaginalis.

Hydrocele is met with at all periods of life; in childhood generally during the first two years after birth, and later in life from thirty to sixty. It is the result usually of chronic inflammation, though there are not wanting instances of *acute hydrocele*. The latter variety may follow an injury to the scrotum or to the epididymis. Congenital hydrocele may exist independently of an inflammatory origin, the fluid accumulating in the sac by gravity, in consequence of the communication between the tunica vaginalis and the cavity of the peritoneum not being interrupted.

The causes of hydrocele are often not appreciable, but in many instances the disease can be traced to blows, to violent muscular efforts in lifting, to the straining which, in stricture of the urethra, is often required to pass the urine, to failure in the funicular process of the peritoneum to close, and to changes in the vaginal tunic incident to advanced life.

These structural alterations consist in thickening, and in the presence of loose, fibrous, cartilaginous, or bony bodies which are adherent to the inner surface of the membrane, and are not unlike those seen in certain joints, as the knee. The disease is often seen in connection with syphilitic sarcocele, or sarcoma of the testis. A common cause of this affection is relaxation in the tissue of the scrotum from intense and protracted heat; hence the great frequency of hydrocele in India, Brazil, and other hot countries. Hereditary influences seem to have sometimes evoked the disease, the most notable example being that given by the late Sir Henry Holland, in which, in one family, three or four successive generations suffered from this complaint.

Epididymitis is frequently followed by hydrocele. The fluid of a hydrocele is usually of a straw color, quite transparent, coagulable by heat, and in its chemical constitution almost identical with the serum of the blood. An analysis made by Bostock of 100 parts of this fluid yielded of water, 91.25 parts; albumen, 6.85; non-coagulable matter, 1.1; and saline matters, .8. Occasionally, instead of presenting the ordinary transparent appearance, the fluid is dark-colored, a condition which is due to the presence of disorganized blood-corpuscles, and, when not the result of an injury, is often associated with a diseased condition of the vaginal tunic.

The milky appearance of the fluid of hydrocele, produced by the presence of fatty matter, described by authors, I have seen four times. The source of this fat is believed by Klebs to be fatty degeneration of the cells lining the serous tunic. Cholesterin is not unfrequently seen in the serum, pre-

sending the appearance of glistening particles. In *encysted* hydrocele the fluid is frequently of a *milky* or *pearl color* and contains spermatozoa. The latter I have seen in ordinary hydroceles, and often, no doubt, these cells reach the fluid in consequence of a slight puncture made by the trocar when the sac is carelessly tapped.

The amount of fluid present in hydrocele varies very greatly, the common quantity being about ten or twelve ounces. The largest tumor of this nature which I have seen measured twenty-one inches in circumference, and contained about thirty-eight ounces of water. The extraordinary case of Gibbon, from whom Cline removed six quarts of fluid, is familiar to most surgical readers; though even this large quantity is less than that in a case mentioned by Dr. Jones,* in which two gallons were drawn.

In 1000 cases of hydrocele treated at the Native Hospital, in Calcutta, and analyzed by Dr. Dujat, the largest quantity of fluid observed in any single case was one hundred ounces.

Opportunities for examining the structural changes which the tunica vaginalis undergoes in hydrocele have occasionally been offered, and in old-standing cases these alterations are very marked,—not unlike those which are witnessed in the pleura after repeated attacks of inflammation. The tunic is thickened with plastic transudations, is rough and fibrous, and often contains calcareous matter. These changes are chiefly limited to the reflected or scrotal part of the membrane.

Occasionally the sac of the vaginal tunic is divided into two compartments by a partition, or by an adhesion of a portion of its two sides, imparting in some instances an hour-glass shape to the tumor. This septum may be either complete or incomplete. I have tapped one chamber and drawn off the fluid without affecting the size or contents of the other in the least. The testicle, though surrounded by the serous accumulation, experiences no injury; but, when the collection is large, it may be somewhat flattened in shape.

When the testis is found diseased, the hydrocele is generally an effect and not the cause of the glandular trouble. In addition to the morbid changes in the tunica vaginalis, there will, in old cases of hydrocele, be others in the surrounding parts, as hypertrophy of the dartos and connective tissue.

Several cases of hydrocele have been recorded in which the sac extended up into the abdomen; the most remarkable of these is one given by Rochard,† in which the tumor extended downward as low as the knees and upward through the canal into the abdomen, as high as the umbilicus. Almost one gallon of a dark-greenish fluid was drawn when the swelling was tapped. I have in at least two instances seen the vaginal hydrocele extend into the inguinal canal.

Encysted Hydrocele.—In that variety of the disease in which the fluid is contained in a sac between the serous membrane and the epididymis, or between the former and the tunica albuginea, the cysts are generally multiple; they are commonly found in persons over forty-five or fifty years of age. In a collection of testes, numbering about thirty-five, in the museum of the University, I found six glands affected with cysts. These cysts seldom attain a size larger than that of a pea. They contain a clear fluid, and often have a pedunculated shape.

A much larger cyst is sometimes met with, having its origin more deeply situated beneath the membrane surrounding the epididymis, and containing, in some instances, two or three ounces of a colorless, non-coagulable fluid.

The fact that these cysts usually contain spermatozoa has given rise to considerable speculation as to the manner in which these cells find their way into the sac. Originating as they do in the parenchyma of the epididymis, it is most probable, as Curling has stated, that the intrusion of these bodies

* Gross's Surgery, vol. ii. p. 851.

† L'Union Médicale, Jan. 27, 1859, p. 70 (Curling).

is the result of accident, from the rupturing of one of the seminiferous tubes of that body. Other writers, as Luschka and Klebs, have thought that the cyst itself is only a dilatation of these tubes.

SYMPTOMS.—Ordinary hydrocele of the tunica vaginalis is usually slow in its formation. The swelling is ovoidal or pyriform in shape, smooth, tense, elastic on pressure, fluctuating, and without pain, redness, or other discoloration. Occasionally the external contour of a vaginal hydrocele is irregular, perhaps constricted in the centre and dilated at each extremity,—a condition due to some inflammatory thickening of the sac rendering it unyielding at certain points.

The scrotum, instead of hanging limp, projects from the body, and if pressed back between the thighs immediately springs forward on being released. When tested by light it is found to be translucent. This last characteristic is most satisfactorily ascertained by examining the patient in a dark room: while a candle or lamp is held on one side of the swelling, the surgeon stoops down on the other side, making the scrotum tense with one hand, while the other is placed in a vertical position on the upper surface of the tumor, in order to intercept the peripheral rays of light. If the sac contains serum, its translucency will be discovered at once. The testicle in hydrocele is situated posteriorly in the vaginal tunic, at about the junction of the middle and lower thirds of the scrotum, except in cases of inversion of the testes, when the latter will be found in front of the sac. When the contents of the hydrocele are milky in color, or when they are mingled with blood, or when the sac of the vaginal tunic has become thickened and rough from repeated plastic deposits, the translucency of the swelling is lost, and the use of the grooved needle will be required. However confident the surgeon may be with regard to his diagnosis of hydrocele, the light test should never be omitted, as he is thereby enabled to ascertain the exact situation of the testis, and thus avoid inflicting any injury on the organ when the trocar is introduced.

DIAGNOSIS.—Hydrocele in the adult is liable to be confounded with hernia, varicocele, hæmatocele, sarcocele, and encephaloid disease of the testis. Errors in diagnosis are so common that it will not be out of place to consider the subject carefully.

The leading differences between hydrocele and hernia will be found in the following table:

HYDROCELE.

The swelling in hydrocele commences at the most dependent part of the scrotum, and gradually ascends towards the external ring.

Hydrocele, when once formed, is a permanent enlargement, and not influenced by position.

The form of the swelling is cylindrical or ovoid. The tumor on percussion yields a flat sound.

Palpation communicates a sense of fluctuation, and coughing causes no succussion or impulse to the fingers.

The tumor has a tense look, stands off from the body, and if pressed towards the perineum and then released springs back to its original position.

The swelling can be illuminated by artificial light, and becomes translucent.

HERNIA.

The swelling in hernia commences above, at the external ring, and descends towards the bottom of the scrotum.

Hernia (if reducible) recedes and disappears when the patient assumes the recumbent posture, and reappears when he is in the erect position.

The form of the swelling is pyriform or round. Should the contents of the sac consist of intestine, the percussion-sound will be resonant.

Fluctuation is absent, and succussion in coughing or straining is noticeable.

The integuments do not appear tense, and the tumor is pendent or pendulous rather than prominent.

In hernia the swelling is opaque.

With so many points of distinction between the two diseases a mistake appears to me to be inexcusable, and yet, I doubt not, the experience of every surgeon furnishes many examples of this error. A short time since I was called to see a case of hernia into which a trocar had been thrust, the tumor having been supposed to be a hydrocele.

The chief diagnostic points of varicocele and hydrocele are as follows:

HYDROCELE.

Hydrocele presents a smooth and uniform surface.

Hydrocele, on pressure, appears to be homogeneous in consistence.

Hydrocele is not affected by recumbency.

Hydrocele rarely causes pain along the cord or in the lumbar region.

VARICOCELE.

Varicocele presents an irregular surface.

Varicocele feels as though made up of a congeries of contorted cords.

Varicocele disappears when the patient assumes the recumbent position.

Varicocele frequently produces pain in the course of the inguinal canal and in the loins.

In consequence of a blow or fall, in which the scrotum is injured, a free hemorrhage occasionally takes place within or without the cavity of the tunica vaginalis, forming a hæmatocele. To distinguish this from hydrocele the following comparisons may be made:

HYDROCELE.

Hydrocele appears usually without having been caused by external violence.

Hydrocele is elastic and rather light.

Hydrocele is translucent.

The integument in hydrocele is free from discoloration.

HÆMATOCELE.

Hæmatocele generally is produced by an injury.

Hæmatocele is more solid and heavy.

Hæmatocele is opaque.

The integument in hæmatocele is often discolored in consequence of the injury, and always so when the extravasated blood is external to the tunica vaginalis.

Sarcocele and encephaloid disease of the testis, while they have a certain resemblance to hydrocele, are not so likely to be confounded with the latter as the affections already described. The characteristics which belong to sarcocele, and which are quite sufficient to establish the diagnosis, are hardness, irregularity of surface, increased weight, and the absence of fluctuation and translucency. Encephaloid disease of the testis, in consequence of the tendency to the formation of cysts filled with fluid and to serous effusion into the tunica vaginalis, possesses in some respects a stronger resemblance to hydrocele than does an enlarged testicle. The differential features will appear in the rapid growth, hard, irregular, nodulated surface, implication of the inguinal glands, want of general translucency, pronounced cachexia, and rapid loss of flesh and strength,—phenomena which belong to malignant disease.

TREATMENT.—The treatment of hydrocele may be either palliative or radical. Spontaneous cures of this affection in a child are not rare. Occasionally it has disappeared on the supervention of an attack of inflammation of the testicle. In young children it is not uncommon for the fluid to be absorbed.

As the disease is not dangerous, and becomes annoying only by its bulk, there are many persons who are content with such treatment as will afford temporary relief. There are other cases in which, on account of a diseased state of the testicle or of the tunica vaginalis, to attempt anything more than this would be improper.

When the object is palliation, the patient may be tapped and the fluid

FIG. 1339.



drawn off. The instrument necessary for the operation is a small trocar and canula. (Fig. 1339.)

The patient sitting with his buttocks over the front edge of a chair, or standing erect, or lying on his back, the surgeon grasps the tumor in one hand, in order to render the tissues tense, and with the other plunges the trocar into the anterior part of the sac, at the junction of the middle and lower thirds of the scrotum, and in a direction inward and upward, in order that no damage may be done to the testis. Any considerable vein on the surface of the skin should also be avoided. The absence of resistance will indicate that the instrument has entered the vaginal tunic, when, upon withdrawing the trocar from the canula, the contents of the sac will escape. The serum having been removed, the canula is to be drawn out. The

FIG. 1340.



Tapping a hydrocele.

small and insignificant puncture will require no dressing, or, if a few drops of blood escape and it is necessary to prevent the linen from being stained, a little strip of adhesive plaster may be used to cover the part. (Fig. 1340.)

Acupuncture, recommended first by Mr. Lewis, of London, has been employed as a substitute for tapping by the trocar. Two or three punctures are made into the sac by a needle, and the fluid finds its way into the cellular tissue of the

scrotum, forming a diffused swelling. The operation may be repeated from time to time.

RADICAL TREATMENT.—There are several different methods of treating hydrocele with the intention of producing a radical cure. One surgeon lays open the swelling and excises a portion of the tunica vaginalis; another introduces a seton; a third will advocate exposing the sac and mopping it well with some stimulating fluid; while a fourth will express his preference for injection. All of these plans, doubtless, succeed, and I have employed all of them. The most simple of all methods is injection. It is an operation which can be done quickly, involves no great amount of skill in its execution, is followed by a short continuance of pain, and, above all, is almost uniformly successful in effecting a cure. I give to this plan an unqualified preference, not on hypothetical or presumptive grounds, but for a reason which alone should influence the surgeon in dealing with questions affecting human health, namely, the uniform experience of success.

The explanation of the well-known discrepancy of views in regard to this simple measure of injection in hydrocele lies not in the method, but in the manner of its execution. When I am informed, on credible authority, that by a given plan for the cure of a particular disease only 3 cases failed in 1148 patients,* I accept it, and try it; and if I do not meet with similar success in my own experience, I infer that some important omission in its employment has been made.

A few silver threads deposited in the sac of a hydrocele may seem very artistic; the excision of the vaginal tunic will yield more blood and attract more attention than an unpretending injection; but, after all, with the last the disability is less and the result as sure. The use of the injection in hydro-

* *Froriep, N. Notizen*, vol. viii., November, 1836.

cele is due, according to Dr. Munro, to a surgeon of his own name who served in the Scotch army during the beginning of the last century. The remedy which he first used was alcohol, afterwards wine. The violent inflammation and suppuration which sometimes followed the use of the first brought discredit upon the practice, especially among British surgeons. Mr. Pott speaks of it as an operation which, happily for mankind, has been laid aside: he lived long enough, however, to alter his opinion. In France they continued to employ injections, using milder fluids, and securing favorable results, as stated by Sabatier, until, finally, the practice became popular in England, mainly through the labors of Sir James Earle. The opposition manifested to this plan arose from different notions as to subsequent effects. Mr. Sharp was afraid of the violent symptoms produced by the spirit of wine. Mr. Douglas thought that the distance between the two layers of the vaginal tunic would render exactness and uniformity in their contact impossible. Le Dran adopted the same view. The theories of cure entertained by the two authorities last named have an extensive prevalence at the present time; that is to say, the disease is supposed to be eradicated by an inflammatory consolidation of the two layers of the tunica vaginalis in its entire extent, thus obliterating its cavity altogether.

Whether this ever takes place to such a degree I am unable to say; but that it is not necessary for the extinction of the disease I very well know, having had an opportunity of examining the parts in a case where the injection had been employed. Bands of organized lymph were found intersecting the cavity of the tunica vaginalis at several points, and a very limited adhesion existed at two or three other localities, but the largest portion of the walls of the sac remained separate, its surface, however, entirely changed, having an irregular, dull, dry, and fibrous appearance. The fluid used by Earle was port wine diluted one-third with a decoction of rose-leaves. The greatest improvement in the injecting material, however, consisted in the introduction of the tincture of iodine, an agent possessing singular efficacy, without tendency to excite suppuration, and producing, when properly used, just that degree of inflammation which yields adhesive lymph. The credit of its application to the treatment of hydrocele in France belongs to Velpeau, although it is alleged to have been well known to the physicians of India. If it has failed to answer the expectations of surgeons, the fault is not in the iodine, but in the manner in which it has been used. Some advise that this agent should be allowed to remain only a short time in the sac, say a few minutes, and then withdrawn; others think that the iodine should be largely diluted with water before using it as an injection, and should be employed in such a quantity as to distend well the tunica vaginalis. Just here, I think, lies the cause of failure, when failure occurs. *The undiluted officinal tincture of iodine should be thrown in and allowed to remain.* The India physicians, it is said, adopted this course, and Mr. Syme strongly insists upon it, forcibly arguing against all attempts to resuscitate the seton in any form whatever.

I have done this operation a great many times, and always with a successful result, when its details have been observed. I can recall one failure only; a case where the hydrocele was of unusual magnitude, measuring sixteen inches in circumference, and with a vaginal tunic greatly thickened. This case was cured by excision, although, perhaps, had a larger quantity of the iodine been used, the result might have been different.

OPERATION.—Making the walls of the scrotum tense in front of the testicle, the surface is carefully inspected, with a view to avoid any venous trunks, and the trocar thrust in a short distance from the most dependent part of the swelling and in a direction somewhat oblique to its longitudinal axis. The absence of resistance will indicate when the cavity of the tunica vaginalis is reached. The trocar is now withdrawn, leaving the canula *in situ*, when a stream of straw-colored fluid will escape into the cup. After emptying the sac of all the fluid, the testicle should be examined with a view to dis-

cover if there is any enlargement or undue sensibility which might render it improper to attempt a radical cure. Finding nothing of this nature, the nozzle of the syringe, charged with two and a half drachms of the tincture of iodine, is inserted into the canula, and, pushing forward the piston, its contents are emptied into the serous sac. The parts are now rubbed together, so as to diffuse the liquid over the entire surface of the membrane, and the canula withdrawn, leaving all the tincture in the sac. The patient begins to complain of a sharp pain, which in a short time will reach the back and produce perhaps a sickening sensation. This is the operation by injection,—exceedingly simple and almost infallible. The patient should now be returned to his bed, and something placed under the scrotum to give it the requisite support. If the pain continues long and is very severe, he should have a quarter of a grain of morphia. His diet should be moderately restricted for two or three days. By the third day the swelling will have increased to nearly its original size, and it will so remain for probably twenty-four or thirty-six hours, when it will begin to subside. At the end of the seventh day the patient may put on a suspensory bandage and get out of bed, going about as he may feel able.

In three or four weeks the swelling will have disappeared and the cure will be accomplished. Double hydroceles may be tapped and injected at the same time with entire safety.

Infantile Hydrocele.—Another form of hydrocele is that belonging to infantile life, and in it, as in the hydrocele of the adult, the disease is situated in the tunica vaginalis. In one variety of infantile hydrocele there is an anomaly of development, a continuity between the cavities of the tunica vaginalis and the abdomen, in consequence of which the serum from the peritoneum trickles down along the cord into the vaginal tunic, and forms the so-called *congenital hydrocele of the tunica vaginalis testis*.

It is supposed by many that in congenital hydrocele of the vaginal tunic, as in hydrocele of the cord, the communication between the abdomen and the tunica vaginalis is free; in other words, that the cord lies loose in the funicular process. Such, however, is not the case. Though not adherent at all points, this process is in contact with the cord in the entire extent of the inguinal canal. There is considerable diversity of opinion as to the proper treatment of congenital hydrocele in its different varieties. Some advise injections of iodine into the sac after the abstraction of its contents. Among the French surgeons alcohol is quite a popular remedy. Should any one be tempted to use either of these agents in congenital hydrocele, the continuity of the vaginal tunic with the cavity of the abdomen must be remembered, in order that pressure may be made at the external ring, to prevent the fluid from entering the peritoneal sac, in the event of which the patient would probably perish from inflammation.

There are three plans which I find entirely satisfactory in the management of all varieties of infantile hydrocele.

First. By expectancy.—Many cases get well without any assistance from the surgeon, and therefore, unless the tumor steadily increases in size, it may be left alone, hoping for such a termination. When the enlargement steadily goes on, an effort may be made to secure the absorption of the fluid by the external application of a lotion of the muriate of ammonia, or by applying the compound solution of iodine.

Second. By excision.—This consists in making a puncture with a sharp-pointed bistoury into the hydrocele and evacuating its fluid, after which the tunica vaginalis, which appears in the wound as a white membrane, should be seized with a pair of forceps, drawn through the wound, and a small portion snipped off with the scissors.

Third. By the seton.—This last method is the one which I generally adopt, and which I regard as in every way satisfactory. It is applicable to all varieties of the disease, and consists in puncturing the sac with a sharp-pointed

bistoury, and along the blade of the instrument introducing a needle armed with a single silk thread, which is brought out through the skin of the scrotum and loosely knotted. The seton serves to drain away the serum and to develop sufficient inflammation to cure the disease. The thread should never be allowed to remain more than twenty-four or thirty hours, after which time it must be removed. If this precaution is observed, there will be little risk of suppuration, and a cure will almost invariably follow.

Encysted Hydrocele is generally of slow growth. The swelling begins at the posterior part of the testicle, which is situated either in front of or beneath the tumor, at the bottom of the scrotum. It is tense, follows the movements of the gland, and is often attended with considerable pain. When the enlargement is multilocular the tumor will present an irregular or uneven surface. The fluid of encysted hydrocele differs from that of an ordinary collection of serum in the vaginal tunic in being as clear and transparent as water,—a circumstance which may serve a valuable purpose in forming a differential diagnosis between the two diseases.

The treatment does not differ from that proper in a case of vaginal hydrocele, namely, tapping and the injection of tincture of iodine. As there may be several cysts, each separate from the others, the proper plan of procedure is, after one sac has been emptied, and before withdrawing the canula, to reintroduce the trocar and puncture a second, third, etc., by simply changing the direction of the instrument. In the same manner the iodine can be introduced. If one of the cysts is quite small it may not be necessary to open it, as it will probably be obliterated by the contiguous inflammation.

A Hydrocele of the Inguinal Canal is occasionally met with dependent on the presence of the undescended testicle. A tense, fluctuating swelling in this region, irreducible, imparting no impulse to the fingers during coughing, and occasioning, when firmly squeezed, a sickening pain, would indicate the nature of the disease, especially if the corresponding side of the scrotum was untenanted.

The radical treatment will require the opening of the sac and the removal of the faulty testicle.

Hydrocele of the Sac of a Hernia.—The neck of a hernial sac may become obliterated either from the long-continued pressure of a truss or by a portion of its contents becoming adherent to its mouth. The pouch below, being a serous structure, may become inflamed and dropsical.

The treatment is the same as that employed in hydrocele of the vaginal tunic, namely, by tapping and injection.

A singular case has been described by Le Dran, in which three varieties of hydrocele existed in the same person and on the same side; that is to say, a hydrocele of a hernial sac, a hydrocele of the cord, and a similar accumulation in the common vaginal tunic.

Hydrocele in the Female.—When hydrocele occurs in the female it is located in those parts which constitute the analogues or complements of the spermatic cord and scrotum in the male, namely, in the funicular process of peritoneum which invests the round ligament as it lies in the inguinal canal, and in the cellular tissue of the labium.

The diseases with which hydrocele in the female may be confounded are hernia, cysts, varicose veins, and oedema. When the fluid is situated in the tubular process of the round ligament or in the labium, the varieties of rupture which it resembles are, in the first case, inguinal, and in the last, obturator hernia. The distinction can be established by attention to the following particulars. In hernia the tumor will be compressible and reducible, and in the act of coughing or straining will communicate to the hand a marked impulse. None of these peculiarities belong to hydrocele. In the case of

cystic growths the differential points are not so easily recognized; it will, however, be found that cysts are sharply circumscribed and project from the mucous surface of the labium. The swelling in hydrocele is more diffused and extends equally in all directions. In doubtful cases the exploring needle will impart much valuable information. In cysts, instead of the fluid being clear or straw-colored, it will be dark and often tinged with blood.

Occasionally the labial veins become varicose, forming a considerable mass on the inner surface of the labium. In the recumbent position such a swelling subsides or can be readily removed by pressure; the mucous surface presents a purple appearance, and the tortuous arrangement of dilated veins can be felt. Hydrocele possesses none of these characteristics. Oedema of the labium is often occasioned by pressure upon the pelvic or abdominal veins, produced by the gravid womb or by ovarian and uterine tumors. Such a swelling possesses many characteristics in wide contrast with hydrocele. In oedema there is neither fluctuation nor translucency present; the parts have a doughy feel, and when pressed upon "pit," retaining for some time the depression made by the finger.

TREATMENT.—Hydrocele, whether in the sheath of the round ligament or in the labia majora, demands no surgical interference so long as the disease shows no tendency to increase. If, on the contrary, the accumulation steadily progresses, it should be treated by the injection of iodine, after which, if the disease is located in the funicular process of the round ligament, a light-pressure truss, with a soft pad, should be applied as soon as the inflammation incident to the injection has begun to decline, in order that the parts may be maintained in close approximation.

In infantile hydrocele of the round ligament, injections, when used, should be very carefully managed. The tubular process of the ligament is likely to be open next to the abdomen, and, if so, would permit the fluid to pass into the general peritoneal sac. Pressure over the upper part of the inguinal canal will prevent such an accident; but it is safer and equally efficient to employ the seton, by introducing a single silk thread into the sac for thirty hours. Infantile dropsy of the round ligament, however, will in most cases undergo a spontaneous cure, or if its disappearance is very slow it may be hastened by the application of a truss: in consideration of these facts it is better not to operate prematurely.

When the fluid is situated in the labium the cellular tissue will generally be pressed aside and condensed, so as to form a single sac, and in such cases the iodine injection will effect a cure with the same certainty as in hydrocele of the tunica vaginalis of the male. Should this not be the case, a closer investigation of the growth will probably prove it to be a cyst, in which event nothing short of the excision of its sac or wall will eradicate the disease.

Complications.—The complications which may occur in a hydrocele are:

First, rupture of the sac from a fall or blow. The fluid escapes into the connective tissue of the scrotum and the penis. This accident may be safely left to natural processes. The extravasated serum will be absorbed, and probably, though not necessarily, a cure will follow.

Second, Orchitis may arise in consequence either of urethral inflammation or of cystitis. The treatment must be directed to the removal of these affections without reference to the hydrocele, and the two may disappear together.

Hernia is not unfrequently associated with hydrocele. In the radical treatment by injection the hernia must be reduced. After the water is removed, and during the injection of the iodine, a finger should be held firmly upon the cord at the external ring, so as to prevent the liquid from passing into the abdomen.

Other plans for the radical cure of hydrocele have been practiced, the most important of which may be enumerated.

Incision is perhaps the oldest of all operations for the permanent cure of

this disease. It consists in dividing the tissues of the scrotum until the sac is reached, which is then laid open in a direction from the upper to the lower part, its cavity stuffed with lint, and the wound allowed to heal by open granulation. The operation is not unattended with danger.

Excision.—By this method the scrotum is incised down to the sac, when the latter is to a great extent dissected out and the wound allowed to heal by granulation. This operation I have frequently seen practiced, and without any bad effects. In the case mentioned in which a very large hydrocele had resisted the ordinary measures of cure, in consequence of the great thickening and alteration in the structure of the sac, I succeeded in eradicating the disease by excising the diseased membrane.

Seton.—The seton, another old plan of treatment, originating with the Arabian physicians, is applied by introducing through the front of the sac three or four threads of silk. The fluid escapes through the punctures made by the needle. The seton must be allowed to remain until a sufficient degree of inflammation is developed to cure the disease. In the hydrocele of children I frequently employ, as already stated, a single thread, which I am careful to remove in twenty-four hours. In one case, where I employed the seton for the cure of hydrocele in an adult, it was followed by severe inflammation and suppuration, by which the life of the patient was for some time seriously jeopardized.

Setons of silver wire instead of silk thread have been used, also catgut, but with no particular advantage. Allied in its operation to the seton was the *tent*, formed of lint or a piece of gum catheter, which was inserted into the sac after evacuating the fluid through a puncture.

Caustic.—The treatment of hydrocele by a potent caustic, such as the caustic potash, was at one time advocated, especially by Mr. Cline. A slough was made by this agent over the scrotum as deep as the vaginal tunic. The inflammation excited in the latter membrane was followed by its contraction and adhesion, or at least by such a change in the inner surface of the sac as arrested further secretion.

Hæmatocele.

Hæmatocele is a collection of blood in the cavity of the tunica vaginalis. The source of the hemorrhage may be the vessels on the exterior of the vaginal sac, or those distributed to the testicle. The accumulation sometimes occurs suddenly, at other times gradually.

CAUSES.—Hæmatocele arises from degeneration of the blood-vessels of the testicle, in consequence of which their walls give way; from inflammatory attacks of the vaginal tunic; from violent muscular efforts exerted in the stooping position; from external violence; and from wounds inflicted on some vessel or vessels of the tunica vaginalis or the testicle in tapping. The disease occasionally exists along with hydrocele. The blood after entering the vaginal tunic remains in a liquid state for some time, though eventually it undergoes considerable change, forming soft, broken-down clots, exhibiting a sponge-like texture, or possibly stratifications of decolorized fibrin.

SYMPTOMS.—Hæmatocele appears as an ovoidal or spherical tumor, largest below, heavy, firm in its consistence, opaque, and without fluctuation. The testicle bears the same relation to the blood in the sac as it does to the swelling in cases of hydrocele; that is, it is placed behind it. When hæmatocele follows an injury of the scrotum, the connective tissue of the latter becomes so infiltrated and discolored by sanguineous extravasation as to mask the presence of fluid in the vaginal sac.

DIAGNOSIS.—Hæmatocele may be distinguished from hydrocele by its greater weight, its imperfect fluctuation, the absence of translucency, and the suddenness with which it often appears. When any doubt remains, the grooved needle will remove all obscurity.

When the hæmatocele occurs in connection with a hydrocele, the nature of the accident may be established by recalling the previous existence of an indolent scrotal swelling, and then considering the fact of its sudden and painful enlargement, not unfrequently attended by considerable constitutional disturbance.

In old or chronic cases the tumor strongly simulates enlarged testicle, being hard, heavy, and inelastic; and as the thickening of the tissues and the solidity of the contents of the sac render it difficult to discover the testicle or to make sufficient pressure to excite the peculiar pain experienced on squeezing the gland, much uncertainty will exist from the similarity of the phenomena. An exploratory incision will furnish the only reliable solution of the difficulty. Castration has in several cases been done, under a misapprehension of the true nature of the malady.

FIG. 1341.



Thickening of the tunics of the testicle, induced by an old hæmatocele.

The structural changes which follow old hæmatoceles are quite marked. The tunica vaginalis is greatly thickened and rough, sometimes containing cretaceous deposits. The connective tissue external to the sac may also be thickened, and the testicle altered in shape, being flattened, the result of pressure. (Fig. 1341.)

TREATMENT.—When the hæmatocele occurs slowly and the collection of blood progresses, the proper plan is to place the patient in bed, support the scrotum, and surround it with cloths dipped in ice-water, or with ice alone, confined in an ice-bag or a bladder. The hemorrhage can in this way be arrested, after which the indication is to favor the absorption of the blood, which process will be facilitated by strapping the scrotum and keeping it elevated. After the lapse of a few days the swelling will begin to disappear. Should the accumulation prove to be large, giving rise to much distention, pain, and tenderness, leeches should be applied over the cord, followed by a brisk cathartic and sufficient opium to allay suffering. When the blood remains fluid without being absorbed, the cure will be promoted by tapping the sac and drawing off its contents. Its re-accumulation will be the signal for a second operation.

When the case is one of hydro-hæmatocele, no operation will be required at once, unless the swelling continues to enlarge, when the sac may be tapped, and, if necessary, this may be repeated from time to time, until all blood disappears from the fluid. After this, if desired, the hydrocele can be treated by tapping and injection.

When the hæmatocele is large and progressing, whether with or without hydrocele, and when, in addition, there are much pain, heat, and scrotal infiltration, indicating inflammatory action, a free longitudinal incision should be made through the scrotum down to the vaginal sac, which also must be laid open on a director or the finger, prolonging the division downward, so as to secure complete drainage. The parts are to be left open to heal by granulation, being merely dressed with some lint moistened with carbolated oil. Cases of old hæmatocele will occasionally be encountered in old persons, in which, from their size, the great thickness of the sac, and the unceasing irritation and pain experienced by the patient, it will be wiser to remove the testicle and the diseased vaginal tunic in their entirety than to resort to either incision or excision of the sac.

Encysted hæmatocele, in which the hemorrhage takes place into a sac or cyst formed over the epididymis or testicle, as in encysted hydrocele, is to be treated on the same general plan as when the blood is poured into the common vaginal tunic.

Inflammation of the Testicle.

Under the head of inflammation of the testicle are included *epididymitis* and *orchitis*. The two affections may exist separately or conjointly, and under two forms,—*acute* and *chronic*. The disease may have a *common* or a *specific* origin.

Common orchitis occurs from both idiopathic and traumatic causes; frequently it is secondary to other diseases.

Specific inflammation of the testicle depends for its existence on a peculiar state of the general system, such as is present in syphilis and tuberculosis.

Epididymitis, or inflammation of the epididymis, sometimes called *hernia humoralis*,—very improperly,—is much more common than orchitis, or inflammation of the secretory portion of the gland, a fact which is probably due to anatomical and functional peculiarities. The epididymis consists of a convoluted duct, its reduplications being held together by a considerable amount of connective tissue, and surrounded by a membrane which gives less support to its structure than that furnished to the glandular part of the organ by the tunica albuginea.

There is a difference of opinion among surgical writers with reference to the side on which the disease exists with the greater frequency. Curling gives 138 cases of orchitis; the disease being on the right side in 78, on the left in 49, and in both glands in 11 instances. Bryant records a similar proportion in an analysis of 73 cases of the disease. On the other hand, Professor Sigmund, from much larger data, namely, 1342 cases of epididymitis, found only one-third of the number on the right side. As far as my own observation extends, the left side is most commonly affected.

In consequence of the continuity of the subserous cellular tissue with the structure of the epididymis, the inflammation more frequently extends to the tunica vaginalis than when the glandular part of the organ is affected, and hence we find that hydrocele not unfrequently follows epididymitis. There is little tendency to suppuration whether the inflammation affects the testis or the epididymis.

CAUSES.—Idiopathic inflammation of the testicle may arise from cold, though the occurrence is by no means common. The causes which usually give rise to the affection are an accidental injury, gonorrhœa, stricture of the urethra, the rude use of bougies, irritating injections into the urethra, cystitis, sexual excesses, prostatic disease, mumps, and a gouty, a rheumatic, or a syphilitic state of the general system. There is a form of orchitis described by Gosselin, and more particularly by M. Berrand, as frequently present in smallpox; it is termed *variola orchitis*.

I have witnessed cases of the disease which appeared to be due to miasmatic causes, and which yielded readily to large doses of quinine. It is impossible to explain on anatomical grounds the frequent occurrence of orchitis as a sequence of mumps. The testicle sometimes becomes inflamed and enlarged in very young children as a result of a contracted prepuce, or a stone in the bladder.

Inflammation of the testicle occurs in the acute and in the chronic form. The acute variety is quite unusual in the glandular part of the organ, but exceedingly common in the epididymis; and an attack of inflammation either in one or the other portion of the testicle predisposes to subsequent invasion. Occasionally both organs are simultaneously affected, or inflammation of one may be quickly succeeded by a similar state of the other testis. I shall speak first of epididymitis, and, secondly, of orchitis.

Epididymitis generally occurs as a consequence of gonorrhœa, or from the use of bougies, or from any irritation located in the prostatic portion of the urethral canal. Its invasion is sudden; the testicle becomes swollen, tender, and painful, and not unfrequently the scrotum is found red and supersensitive, and even cedematous. Pressure made on the spermatic cord occasions con-

siderable uneasiness. Often the earliest symptoms experienced are tenderness along the cord, and a hard, swollen state of the vas deferens. The pain, in virtue of the distribution of the nerves of the cord to the iliac region and the groin, and their origin from the lumbar plexus, extends to the inguinal region and to the loins. The irritation is frequently reflected to the bladder, compelling the patient to pass water with unusual frequency. On examining the testicle, the swelling will be found to be confined to the posterior border of the gland, having an elongated, crescentic shape, and to be greatest at the lowest part of the epididymis or at the globus minor. The inflammation frequently extends to the tunica vaginalis, and is followed by serous transudation into its cavity, in which case the swelling becomes so diffused and general that it is impossible to trace the outlines of the epididymis.

This extension of inflammation from the epididymis to the vaginal tunic, rather than to the glandular part of the organ, is most probably due to the continuity of the connective tissue of the two structures. The system strongly sympathizes in the local disturbance, as is seen in the elevated temperature and accelerated circulation which attend the inflammation.

When epididymitis is secondary to gonorrhœa, it is thought that the inflammation reaches the testicle by travelling from the prostatic urethra along the ejaculatory duct and the vas deferens. This is not impossible; but I am disposed to believe that the nervous relation which subsists between the urethra and the epididymis is more actively concerned in causing the disease; in other words, that it is a transferred or reflex rather than a propagated process, similar in kind to what is frequently observed in sympathetic ophthalmia, rheumatism, or gout. Brodie, Sir Astley Cooper, and Curling favor the theory of inflammatory extension by continuity of tissue; but there are no facts to corroborate such a view.

Generally the disease attains its height in the course of six or seven days, when the arterial excitement begins to abate; the pain subsides along with the swelling, and in the course of from twenty to twenty-five days, under judicious treatment, the disease has passed away. Indeed, the tendency is always to resolution, suppuration being exceedingly uncommon. Traces of the attack often remain for a long time after the affection has disappeared. The regular outline of the epididymis is interrupted by masses of lymph, which remain and give to the body an irregular surface, or occasion a marked hypertrophy of the globus minor. If the vaginal tunic has been involved in the disease, a certain degree of thickening of that membrane will also remain.

TREATMENT.—The treatment of a case of acute epididymitis must be actively antiphlogistic. Rest in the recumbent position should be strictly enforced. If the inflammation has succeeded to a gonorrhœa, all urethral injections must be suspended. Often, indeed, the discharge from the urethra is suspended during the active inflammatory stage of the epididymitis, the latter acting as a derivative. Experience has shown the old practice, taught by Bloomfield, of restoring the urethritis in cases of gonorrhœal epididymitis by the introduction of bougies into the canal, to be worse than useless.

If the inflammatory symptoms are urgent, the hair may be shaved from over the cord at the external abdominal canal and a few leeches applied. They must not be placed on the scrotum, as their bites are followed by extensive discoloration, from the extravasation of blood into the loose connective tissue of the part. With a view to drain the blood out of the testicle, the latter should be elevated, by placing beneath the scrotum a cushion, or by suspending it in a sling formed out of a handkerchief folded in a triangle and with its vertex and ends secured to another round the body. (Fig. 1342.) Previous to thus supporting the scrotum, the latter should be enveloped in a lotion of lead-water and laudanum, which can be renewed every three or four hours. The bowels are next to be cleared by an active cathartic.

If no amelioration of the disease is experienced after the lapse of thirty-six hours, the scrotum should be blistered by drawing longitudinally over its posterior surface a number of lines of nitrate of silver. In twenty-four hours each cauterized track will present a vesicated surface, the pain of which can be materially lessened by a hot-water dressing.

Opiates will be required whenever the suffering is sufficiently great to prevent sleep, and among this class of remedies none seem to answer a better purpose than Dover's powder, or the sulphate of morphia associated with extract of hyoscyamus (morph. sulph., gr. $\frac{1}{4}$; ext. hyoscyami, gr. i), and administered at bedtime. If there is much febrile excitement, the neutral mixture, with a small amount of morphia and tartar emetic, can be given with advantage during the day.

By the above treatment a mastery will generally be early acquired over the disease, after which the pain and swelling gradually subside, leaving only the plastic infiltration to be removed. To accomplish this, the scrotum may be thoroughly painted with the compound solution of iodine, or, what is preferable, compressed by the turns of a narrow elastic rubber roller, or by careful strapping with adhesive plaster, a practice introduced in 1835 by Fricke, of Hamburg, though Dr. Joseph Parrish, as early as 1800, had applied pressure by means of a narrow roller for a similar purpose. The application of adhesive strips is made as follows. The hair being removed, the testicle is drawn down into the bottom of the scrotum by grasping the latter at the cord between the thumb and index finger of one hand, and, while elongating the parts by traction, with the other hand apply a strip of plaster, about three-quarters of an inch in width and six or seven inches in length, around the scrotum a number of times, immediately above the fingers, with sufficient firmness to confine the testicle in the sac below. The remaining part of the scrotum is then covered in by strips of plaster partially overlapping one another, applied obliquely in a vertical direction from the neck of the purse, down over one side of its fundus and up over the other, the strips crossing above, so as to form a spica. (Fig. 1343.) The patient may possibly complain of some uneasiness for a time, in consequence of the pressure, but generally this gradually wears away. Should it, on the contrary, increase, the compression must be removed, as the time has not arrived for its use.

The strapping ordinarily requires to be removed and replaced every day until the swelling and induration of the epididymis have disappeared.

In case the induration still lingers, benefit will be derived from the internal use of the iodide of potassium, and also from alterative doses of mercury. If the patient is weak and pale, the iodide of iron, or quinine and iron, will be indicated. Generally any effusion into the vaginal tunic which may have existed disappears along with the induration of the epididymis. When there is reason to suspect a miasmatic origin of the epididymitis, full doses of quinine must be given.

In some instances the globus major and minor will remain permanently enlarged, unattended with any pain or special inconvenience. The effect of this hardness is often sufficient to occlude or obstruct the canal of the seminal

FIG. 1342.



Sling for the testicle.

FIG. 1343.



Adhesive strips applied to the testicle.

duct to a degree which will prevent the passage of the spermatozoa, thus rendering the patient sterile as long as the condition exists. As epididymitis is frequently excited by the reflected irritation of urethral stricture, the latter should be corrected as promptly as possible, otherwise the individual will be subject to recurring attacks of inflammation in this part of the testis.

Acute Orchitis is not uncommon, and may arise from blows, kicks, forcible compression of the testes, mumps, tuberculosis, syphilis, rheumatism, and occasionally from an extension of inflammation from the epididymis when that body is affected. It is rarely produced by gonorrhœa. An undescended testicle is very prone to an acute inflammatory attack in the course of its transit from the inguinal canal to the scrotum. Orchitis may be unilateral or bilateral. The right gland is oftener affected than the left: when the disease occurs in children, as it occasionally does, it is, I believe, uniformly one-sided.

SYMPTOMS.—The testis, when inflamed, becomes rapidly swollen, though still retaining its natural oval form, with the exception of being somewhat more flattened. The gland feels heavy, and the pain, which is dull, is of a sickening nature, and radiates in the direction of the groin, hip, perineum, and loins. As the disease progresses, the scrotum becomes swollen, red, and tender, and all the parts so exceedingly sensitive that the patient keeps the limbs asunder, and, when standing, inclines forward, so as to avoid all pressure on the testicle. When the orchitis is the result of causes connected with the late descent of the gland, it is accompanied by symptoms strongly simulating those of strangulated hernia, abdominal pains, nausea, vomiting, and constipation being present in the majority of cases.

The symptomatic fever which accompanies the disease is quite marked, the heat of the body rising sometimes to 103°, with thirst, dry skin, headache, and scanty urine. As has been already stated, there is less tendency in orchitis for the inflammation to extend to the tunica vaginalis than in epididymitis, and consequently in the former disease fluid in the serous sac is not very common.

As in epididymitis, the inflammation reaches its height in seven or eight days, gradually declining, until at the end of three weeks it has disappeared.

PATHOLOGY.—Inflammation of the testis manifests little tendency to supuration, though this result is sometimes witnessed, the pus being either disseminated through the connective tissue supporting the seminiferous tubes, or inclosed in a cyst, the latter being formed by circumferential infiltration, as in ordinary abscess. When the purulent matter is diffused, the gland-structure is liable to become destroyed, leaving the tunica albuginea only an empty or flaccid bag. In aggravated cases, even this membrane undergoes ulceration or sloughing. Ordinarily, however, the inflammatory change observed in simple orchitis is a fibrinous and cell infiltration in the midst of the tubuli seminiferi, which causes the swelling and pain, and which disappears by absorption on the subsidence of the disease, though often leaving the testicle either softened or somewhat atrophied, and predisposed to subsequent attacks on very slight provocation.

DIAGNOSIS.—Inflammation of the glandular part of the testicle may be distinguished from epididymitis by the form of the swelling, which in the first-named affection is ovoidal and flattened, while in the latter it is elongated, crescentic, and limited to the posterior border of the organ.

The pain is unlike that of epididymitis, being more severe, dull, and sickening. The sense of great weight experienced in orchitis is also diagnostic. In epididymitis uneasiness is first felt in the cord, which is not the case in orchitis. Orchitis in its course is chronic; epididymitis, acute. Fluid in the vaginal tunic is uncommon in the former, very common in the latter disease. Impotence is liable to result from orchitis; rarely, if ever, from epididymitis. To these differential symptoms may be added dissimilarity of

origin, and effect on the constitution at large; orchitis, except when produced by traumatic causes, being generally the result of either mumps or constitutional conditions, such as tuberculosis, syphilis, variola, or rheumatism, and accompanied by disturbance of the general system; while epididymitis is usually the result of disease of the urethra.

TREATMENT.—Inflammation of the glandular portion of the testis is, at its commencement, managed very much as an epididymitis, namely, by rest in the recumbent position, and the application of a few leeches in the course of the cord, followed by cold lotions of lead-water and laudanum. The scrotum should be elevated, and supported on a cushion or in a handkerchief sling. When there are much heat and pain, I have witnessed the most decided relief follow the use of ice, the most convenient mode of applying which is by breaking it into small pieces, and, after putting it into a thin gum bag or a bladder, placing the latter beneath the scrotum. Sometimes cold increases instead of lessens the suffering, and when this is found to be the case it is well to be guided by the sensations of the patient,—to resort to hot fomentations of laudanum and water, or, what will often answer better, to surround the parts with a flaxseed-meal poultice containing two or three leaves of tobacco. While it is desirable in all cases to keep the bowels regular, in a strong, robust patient in whom the symptoms are decidedly acute the treatment may commence with an active purge. The pain and constitutional disturbance when severe must be moderated or controlled by opiates in combination with refrigerant mixtures, as the neutral mixture or spirit of nitre. When the violence of the attack has passed over, and the swelling and sensibility are on the wane, compression by adhesive strips, or by a narrow gum-elastic roller, can be employed with the same advantage as in epididymitis. Some of the French surgeons advise, in obstinate cases of orchitis, attended with fluid in the vaginal tunic and severe pain, to puncture the tunica vaginalis; and there can be no objection to the operation. The relief from pain which follows this procedure, by which the fluid contents of the serous sac are discharged and the pressure on the testicle is relieved, is very decided indeed, and in this consists its chief value. I cannot, however, claim as much for the operation of incising the tunica albuginea, which has been highly extolled by Vidal de Cassis. Such an incision is not without danger to the structure of the testis, from the escape of the seminiferous tubes through the opening made in the fibrous membrane. Demarquay, Salleron, and M. de Castelnau have each reported a number of cases in which the testicle was either entirely destroyed or seriously damaged in this way, which is a sufficient reason for the condemnation of the operation.

Orchitis following mumps demands no special treatment other than rest, attention to the bowels, and an anodyne lotion. It disappears with the subsidence of the parotiditis. It is rarely followed by any atrophy of the testicle. Only in cases where the inflammatory action is severe will it be necessary to resort to active antiphlogistic measures.

In *rheumatic* or in *gouty* orchitis, the ordinary antiphlogistic remedies avail very little. Iodide of potassium, salicylic acid, tincture of guaiac, and colchicum are best adapted for such cases. Blistering the scrotum may also be employed with advantage.

Chronic Orchitis, though occasionally following acute inflammation of the gland, is generally symptomatic of a constitutional diathesis (syphilitic or tubercular). The disease is chiefly remarkable for the quiet manner in which it progresses. The testis is enlarged, hard, and flattened; at first without any surface irregularity, and with little or no pain save in exceptional cases. Even when the testis is forcibly compressed or squeezed, there is an absence of the usual sickening sensation, particularly when the disease has existed for some time. Occasionally the inflammation extends to both the epididymis and the tunica vaginalis, and is followed by serous effusion into the cavity of the latter.

MORBID ANATOMY.—Allowed to progress without treatment, chronic orchitis from local causes will certainly cause irreparable structural alterations in the testis. The gland when laid open exhibits a yellow, cheesy deposit, sometimes appearing as a single central mass, at other times in several places through its substance, and which becomes so closely incorporated with the glandular part of the testicle as to be inseparable from it. The seminiferous tubes are also filled with a yellowish-brown substance, rich in cells. In addition, there is an infiltration which interpenetrates the



FIG. 1344.
Section of a testicle exhibiting fibrous degeneration and showing two spaces filled with caseous matter.

seminiferous tubules, is gradually developed into fibrous tissue, and, with the intertubular deposit, finally replaces the glandular components of the organ. (Fig. 1344.) In some instances suppuration follows; the tunica albuginea ulcerates, and the secretory structure of the gland is destroyed, leaving a withered and shapeless mass of connective tissue.

TREATMENT.—In the form of orchitis under consideration, careful attention should be given to the improvement of the general health, which is often seriously at fault, and with this object in view the diet must be nutritious, the bowels carefully regulated, and tonics in combination with alteratives exhibited,—iodide of iron, iodide of mercury, and cod-liver oil being the most valuable. Inunction of the testicle with iodoform or mercurial ointment exerts a favorable influence in removing the infiltration; and when these cease to do good, strapping may be used instead. If there is reason to suspect the existence of pus within the tunica albuginea, which may be determined by the use of the exploring needle, it should be evacuated as in an ordinary abscess.

When the gland remains chronically enlarged, it has been suggested to expose the cord, and isolate and tie the spermatic artery, thus cutting off the supply of blood and inducing atrophy. This operation was first executed by Harvey, the discoverer of the circulation, and has also been performed in two cases of sarcocele with success by Maunior, of Geneva.

Syphilitic Orchitis, another variety of chronic inflammation, commences in so quiet and painless a manner that in many instances the disease has made considerable progress before the patient has discovered its existence. Frequently both testes are simultaneously affected. The gland soon becomes irregular, knotty, and heavy, and the serous or vaginal tunic frequently contains fluid. This affection, which is usually designated *syphilitic sarcocele*, is among the later or tertiary manifestations of the disease. It is occasionally seen in children shortly after birth, and is due, most probably, to inherited syphilis.

MORBID ANATOMY.—The pathological alterations which occur in syphilitic inflammation of the testes are usually confined to the body of the gland, and consist in a hyperplasia and condensation of its interstitial or connective tissue. This abundant new formation of connective tissue, unequally distributed between the lobuli testis, is partly concerned in causing the irregularity of surface noticed in this variety of orchitis. There is also a large amount of a dense fibrogenous material irregularly deposited between the lobules, and also in different parts of the tunica albuginea, including the mediastinum testis, the presence of which, for the most part, gives rise to the nodular or knotty condition of the gland.

In the midst of these undivided masses of connective tissue there lie diffused many cells in various stages of fatty degeneration, which impart a yellowish appearance to the morbid product, the whole constituting the gummy tumor so frequently observed in tertiary syphilis. The serous tunic

is also the subject of inflammatory thickening, and its cavity generally contains a considerable amount of yellow serum.

Should no attempt be made to interrupt the progress of the disease, the constant addition to, and the continued condensation and contraction of, the interlobular formation, will finally encroach so much on the seminiferous lobules as to cause wasting and destruction of their ducts, leaving only a mass of fibrous tissue instead, and necessarily destroying the function of the testicle.

Should the testes in this condition, from any cause, traumatic or otherwise, experience an additional inflammatory attack, suppuration may follow, the pus collecting into little depots in the midst of the seminal lobules, or occupying the entire sac of the tunica albuginea, and destroying the gland-tissue by the pressure caused by the resistance of the fibrous coat.

DIAGNOSIS.—Attention to the following considerations will enable the practitioner to recognize with tolerable certainty a case of syphilitic orchitis, namely, the simultaneous invasion of both testicles; the absence of pain or any of the phenomena of acute inflammation; the extreme hardness and weight of the gland; its irregular and knotty form; the absence to the feel of all distinction between the testis and the epididymis, in advanced cases; and, finally, a history of pre-existing syphilis.

TREATMENT.—In syphilitic orchitis, the fluid, when existing in any considerable quantity in the vaginal tunic, should be removed by tapping, after which the patient must be placed on the iodide of potassium, with or without mercury. Six to twelve grains of the former may be administered, three times a day, in any convenient menstruum. Or there may be added to each dose of the mixture one-sixteenth of a grain of the bichloride or the biniodide of mercury. In addition to the internal remedies, inunction of the scrotum with mercurial ointment, either alone or associated with iodoform, will conduce to the cure. In good constitutions, mercury alone, in small alterative doses, will exert a powerful influence in determining the absorption of the fibrous and gummy deposits. For this purpose one-fourth of a grain of calomel may be given four times a day, until a diminution of the enlargement is noticed, taking care not to push the drug to the extent of salivation. Should the mercurial disturb the bowels, it can be combined with a very small quantity of opium. The orchitis which is sometimes witnessed in very young children is generally the result of inherited syphilis, and yields to both the iodide of potassium and the mercurial treatment.

Tubercular or Strumous Orchitis is not an uncommon affection. It is met with at all ages, though commonly between the ages of twenty-five and thirty-five, and involves both the body of the testis and the epididymis, the latter generally being first affected. Like syphilitic orchitis, it is often bilateral.

SYMPTOMS.—The commencement of tubercular or strumous inflammation of the testicle is not announced by pain or any other sign calculated to attract at an early period the notice of the patient. The gland becomes hard, knotty, and irregular in form, and the same condition not unfrequently may be detected in the vas deferens and seminal vesicles. Compression of the gland does not cause the peculiar sensation produced by pressure on the sound organ. The skin over the testicle remains unaltered in appearance and moves freely over the gland, unless suppuration takes place, when it becomes œdematous, adherent to the tunica vaginalis and tunica albuginea, and finally ulcerates, the pus and glandular tissue of the organ being discharged through the opening. There is in these cases of tubercular orchitis a strong tendency to the formation of abscesses, which after discharging their purulent contents leave fistulous openings which remain sometimes for years exhibiting no disposition to heal. When both testes are involved, the sexual appetite is very much lessened, and may be entirely lost. Not

unfrequently the disease of the testicle has been preceded by tuberculosis of the lungs.

MORBID ANATOMY.—The structural changes observed in tubercular orchitis differ considerably from those which belong to syphilitic sarcocoele. The general appearance presented is that of round or irregular cheesy masses or nodules. These masses in some places are distinct or isolated from one another, and in other parts of the organ are blended. Externally they are quite firm, even elastic; but, their vitality being low, they are prone to contraction, softening, and suppuration. In tracing the location of the new formation, and its relation to the seminiferous tubules, there appears to be a cell-infiltration occupying the peri-tubular lymph-spaces, partly undergoing a fibrous transformation, and constituting the true nodular tubercles. While these changes are going on in the interlobular spaces, the interior of the seminiferous tubes of both the epididymis and the testis are not exempted from the morbid action. They become distended by an accumulation of proliferating endothelium, granular matter, and a yellowish-white cheesy material, which infiltrates and disorganizes their walls, until finally all traces of secretory and conducting structure disappear, and both the testis and the epididymis are converted into a sac filled with this peculiar serofulous material. This deposit has been shown by Dr. Clark to undergo different changes, one part, particularly that near the centre, consisting chiefly of granular material, while nearer the circumference cell-forms prevail, and throughout the gland are to be seen particles of fat and crystals of the triple phosphate of lime. It is not improbable that these crystals are derived from decomposition of the seminal secretion. There are, therefore, in the form of tissue-degeneration under consideration both an extra-tubular and an intra-tubular deposit, the first located in the inter-tubular connective tissue, the second within the tubes of the testicle. By those who make a distinction between tuberculosis and scrofula these two depositions have been regarded, without, I think, sufficient reason, as distinct kinds of morbid material, the former being tubercular and the latter serofulous in its nature. Both are equally destructive to the gland, the former causing the absorption of the walls of the seminiferous tubes by external compression, and the latter by infiltration, or, as the so-called tubercular and serofulous depositions exist at the same time, the disorganization is the conjoint effect of both processes.

In certain constitutions the disease is not limited to the tubular structure of the testis and epididymis, but may extend through the entire length of the vas deferens, seminal vesicles, ureters, and kidneys.

TERMINATIONS.—The termination of a case of tubercular or strumous testicle is not always the same. Frequently the serous and fibrous coats of the testicle become adherent to the scrotum through adhesive inflammation. While the deposit within the tunica albuginea is being gradually replaced by a collection of pus, ulceration follows, giving rise to one or more fistulous openings, which continue to discharge indefinitely, or a fungous growth may protrude through one of the sinuses. This constitutes the "hernia testis."

Again, when the disease affects principally the epididymis, and is followed by ulceration of the scrotum and the tunica vaginalis, the body of the testicle, with its fibrous coat unbroken, may prolapse through the external opening.

Under favorable circumstances the morbid deposit may undergo changes which will leave the testicle without serious damage. These retrograde metamorphoses may result, when the formation has been of limited extent, in its complete removal by absorption, or, after its more liquid portions have been absorbed, in a fatty degeneration of the residue, by which it is converted into a dry, cretaceous mass. This, like any other foreign substance, may become encysted in a wall of lymph, and repose harmlessly in the testicle, giving the patient no future trouble.

DIAGNOSIS.—Tubercular and strumous orchitis may generally be distinguished from syphilitic orchitis by the following considerations:

SYPHILITIC ORCHITIS.

The body of testis first affected.
 May occur at any age after puberty.
 Uniformly hard; not markedly irregular, except at first.
 Little tendency to suppuration, rather to fibroid degeneration.
 Fistulæ uncommon.
 Fungous outgrowths rare.
 Health unaffected.
 Other syphilitic manifestations.

TUBERCULAR AND STRUMOUS ORCHITIS.

Affects primarily some part of the epididymis.
 Not often seen after thirty.
 Knotty, irregular, with intermediate soft points.
 Softening and suppuration common.
 Fistulæ common.
 Fungous outgrowths common.
 Health generally impaired.
 Tubercular diathesis, other organs being involved.

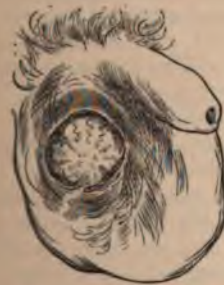
TREATMENT.—The treatment of chronic orchitis consists in improving the general health by good diet and by moderate exercise in the open air. Internally, iodide of potassium, iodide of iron, and cod-liver oil are the most potent remedies. Locally, an ointment of iodoform or of the iodide of lead will favor the work of absorption. When suppuration occurs, the abscesses, if well matured, should be lanced. If they are allowed to open themselves, there will be a greater tendency to the formation of others.

The ulcerated openings require to be touched with nitrate of silver, and, when the discharge is not profuse, the scrotum may be advantageously strapped. Under this treatment the fistulæ occasionally heal and the patient recovers.

Excision of the diseased testicle should be practiced only as a last resort and when the surgeon has indubitable evidence of the utter and hopeless disorganization of the organ. In more than one instance I have seen recovery take place after the gland had been doomed to the knife.

Fungus of the Testicle exists under two forms: first, as an ash-colored or yellowish mass protruding through an opening in the scrotum (Fig. 1345), made up of seminiferous tubes and granulation tissue, and from which is discharged a thin, ichorous matter; secondly, in a growth of granulations from an exposed portion of the tunica vaginalis and tunica albuginea; in both instances the result of disease of the testicle. (Fig. 1346.) At one

FIG. 1345.



Fungus, or "hernia testis."

FIG. 1346.



Fungous granulation from the tunica albuginea of the testicle.

time they were regarded as malignant, but their benign character was recognized by Lawrence* many years ago, to whom also we are indebted for a rational plan of treating the disease. The fact of their being often non-malignant has originated for these growths the name "benign fungus." The absence of any very unpleasant odor, the peculiar pain of the testicle produced by pressure on the granulatory mass, and the absence of any tendency to hemorrhage, are sufficient to distinguish benign fungus from malignant disease.

The plan of treatment generally adopted, and which answers well in most cases, consists in cauterizing the surface of the fungus with nitrate of silver, placing compresses of lint on its surface, and then applying pressure by ad-

* Edinburgh Medical and Surgical Journal, 1803.

hesive plaster. This dressing is to be renewed from day to day until the growth has been reduced to a level with the integument, when the edges of the opening in the scrotum are to be gradually brought towards each other by adhesive strips, until finally they are closed over the granulating mass. Syme in two or three instances attained the same result by loosening up and paring the edges of the opening, and uniting them over the fungus by sutures.

Encephaloid Disease of the Testicle is the form of cancer which usually occurs in the testicle. This affection is peculiar to no age. Of the 51 cases collected by Mr. Ludlow, 5 were in children under five years of age; 1 in a boy; 11 in persons between twenty and thirty; 22 between thirty and forty; 6 between forty and fifty; and 6 between fifty and seventy.

Of 16 cases analyzed by Mr. Bryant, 1 was under five years of age; 1 between fifteen and twenty; 5 between twenty and thirty; 5 between thirty and forty; 2 between forty and fifty; and 2 between fifty and seventy.

Malignant disease of the testicle is invariably unilateral. In the cases which have come under my own observation, the right gland has been most frequently affected. An undescended testicle is liable to become the subject of cancer.

SYMPTOMS.—Encephaloid disease of the testicle commences by the deposit in the seminiferous tubes of one or more small nodules, which, rapidly enlarging, soon involve both the body of the testis and the epididymis, without manifesting any signs of inflammation. The swelling is at first smooth and hard, a condition which it retains as long as the structure of the tunica albuginea is not materially injured. When, however, the fibrous coat begins to yield, the part becomes soft and almost fluctuating. The pain is rarely shooting, or lancinating, generally a dull ache. Pressure occasions none of the sensations experienced when the sound gland is squeezed. After a time the tunica albuginea gives way in one or more places, allowing the growth to protrude, and giving an irregular surface to the tumor. At several points soft, fluctuating swellings or cysts appear; the veins over the distended scrotum become dilated, the cord thickened, and, finally, the lymphatic glands enlarged. The tumor in many cases acquires an enormous bulk, equal in size to a cocoanut or a child's head. When ulceration takes place, the tumor protrudes in the form of a horrid, bleeding fungus (Fig. 1347), from which is discharged a stinking sanies. The general health rapidly fails, the face becomes sallow, and the body emaciates, the disease terminating fatally in from eight to twenty months.

FIG. 1347.



Encephaloid fungus.

DIAGNOSIS.—Encephaloid disease of the testicle may be confounded with syphilitic or tubercular orchitis. The characteristics of the three diseases are contrasted below:

ENCEPHALOID ORCHITIS.	SYPHILITIC ORCHITIS.	TUBERCULAR ORCHITIS.
No history of malignant antecedents.	Syphilitic history.	Tubercular history.
Begins in the body of the organ.		Begins in the epididymis.
Rapid in its course.	Slow in its progress.	Slow in its progress.
Skin of the scrotum finally involved.	Skin rarely involved.	Skin involved only just before formation of abscess.
Ulceration and fungus common.	Ulceration or suppuration rare.	Suppuration common.

ENCEPHALOID ORCHITIS.	SYPHILITIC ORCHITIS.	TUBERCULAR ORCHITIS.
Pain severe, lancinating in an advanced stage.	Weight without pain.	Little pain.
Soft and fluctuating.	Hard.	At first hard.
Net-work of large veins over surface of tumor.	Not so.	Not so.
Attains great size.	Moderate size.	Moderate size.
Painless on pressure.	Painless on pressure.	Painful on pressure.
Generally one testicle affected.	Often both.	Often both.
Fungus always present in advanced stages.	Fungus rare.	Fungus common.
Bleeds freely, very rapid growth, offensive odor.		
Rarely extends beyond twenty months.	Many years.	Several years.
Fatal.	Curable.	Generally incurable.
Inguinal and lumbar glands, skin, and cord affected.	Bubo may be present.	No inflammation of the inguinal or lumbar glands.

MORBID ANATOMY.—The infiltration is found affecting the body of the testicle, the epididymis, the vas deferens, and the pelvic lymphatic glands. As this cell-infiltration is irregularly disseminated, the softened, white, pul-taceous material which follows is found in patches instead of being regu-larly distributed through the structure of the gland. Histologically, the source of the cells which confer the specific or malignant character on the growth is the epithelium of the seminiferous tubules, the proliferation of which constitutes the primary stage of the disease, preceding, in order of time, the intertubular infiltration. So far as can be determined by a simple inspection of the morbid growth by the unaided eye, there is nothing by which it can be distinguished from sarcoma. The fungous growth which protrudes after the tunica albuginea gives way consists very largely of an exceedingly fine and complex net-work of vessels, developed from those occupying the inter-tubular connective tissue of the gland.

TREATMENT.—Excision of an encephaloid testicle tends to prolong life, but is powerless to cure, the disease uniformly returning. The operation, how-ever, should be limited to the latter stages of the disease, when the tumor is about to ulcerate, or when the fungous growth is already existing. By the use of the knife under these circumstances the foul mass of diseased granu-lations with its unpleasant odor is removed for a time and the hemorrhage prevented.

Opiates to relieve pain and procure rest may be administered, together with tonics and a nutritious diet, and at the same time the parts should be kept in a cleanly state, when ulceration has occurred, by frequent ablutions with a solution of the permanganate of potash, bromo-chloralum, or nitrate of lead.

The results of operations performed for cancer of the testicle are not of a very encouraging nature. Of 36 cases reported, 7 died,—3 within one week, 2 within six weeks, and 2 within three months.* And yet there are quite a number of cases recorded in which life was doubtless prolonged by the operation of castration, and in some of which the disease was possibly cured.

Curling has collected 9 cases in which the patients were living after the excision of the testicle for cancer; 1, fifteen years; 1, five years; 1, seven years; 1, twelve years; 1, nine years; and 4, five, four, three, and two years respectively. The period at which the disease returns after the excision has been recorded by Mr. H. Ludlow in 23 cases. In 13 of these there was a recurrence of the cancer at various periods from six to eighteen months. In 5 the patient enjoyed exemption for two years; in 4, for three years; and in 1, for ten years.

With the exception of melanosis, and that rarely, the other varieties of cancer are never met with in the testicle.

* Medical Journal and Gazette, vol. xix.

Sarcoma.—This affection is not so common as encephaloid disease. Its occurrence is restricted to early life, rarely being seen after the twenty-seventh year or under the fifteenth. It is remarkable for combining in itself all the histological elements peculiar to the different species of sarcomata; and not only so, but these growths are singularly associated with cyst, cartilage, fibrous, mucous, adipose, and muscular tissue.

SYMPTOMS.—Sarcoma of the testicle is generally unilateral, and begins in the body of the gland, though it may subsequently extend to the epididymis. The progress of the tumor is slow and unattended with pain, though, after it has attained considerable bulk, a sense of dragging and uneasiness is experienced from the weight of the growth.

For some time the testicle preserves its oval form and smooth surface, and may readily be distinguished from the epididymis. This distinction is finally lost by the extension of the disease, and the smooth surface of the swelling is replaced by irregularities frequently due to the formation of cysts.

Notwithstanding the tumor may attain great magnitude, the skin remains movable over its surface, the superficial veins are unchanged, and ulceration does not occur. Should the disease not undergo an encephaloid change (one to which it is strongly predisposed), it may continue for several years without materially affecting the general health of the patient.

DIAGNOSIS.—Sarcoma may readily be confounded with encephaloid disease of the testicle, and, as has been stated, the two are frequently found existing together. In typical cases of the two affections, however, there are certain differences which will serve to establish the distinction.

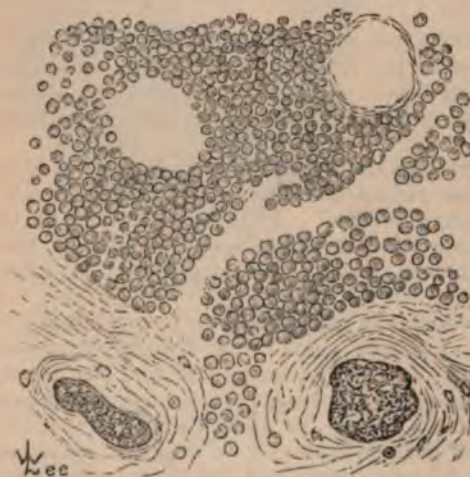
SARCOMA.

Limited to early life.
Health remains unaffected.
Slow growth.
Does not ulcerate.
No fungous growth.
Painless.
Skin not implicated.
Fluid in the vaginal tunic rare.
Involves the epididymis late.

ENCEPHALOID DISEASE.

May occur at all periods of life.
Health suffers, especially when fungus appears.
Rapid growth.
Ulcerates.
Fungous growth.
Painful.
Skin implicated.
Fluid in the vaginal tunic common.
Involves the epididymis early.

FIG. 1348.



Microscopic view of a sarcoma of the testicle. The upper portion of the cut shows the peculiar wall-less blood-vessels lying between round embryonic cells; in the lower portion is seen the atrophied glandular structure with two seminiferous ducts in transverse section.

HISTOID ELEMENTS.—In pure cases of sarcoma of the testicle there exist a vast number of both round and spindle cells, with a fibrillated, intercellular net-work. (Fig. 1348.)

PROGNOSIS.—In consequence of the very common intermingling of both encephaloid and sarcomatous elements, the prognosis in these tumors of the testicle is extremely unfavorable either without or with an operation.

Notwithstanding the frequent recurrence of sarcoma after excision, it will occasionally happen that the patient will enjoy immunity from the disease for one or even two years; and with this prospect in view, together with the peace of mind which follows the removal of an affection which is daily a source of

anxiety, I always advise an operation unless the tumor manifests a quiescent

sition. I have many times performed this operation, and have found reason to modify this opinion.

nphadenoma of the Testicle is a rare variety of the disease which greatly resembles medullary cancer. Its chief difference from ordinary sarcoma consists in the greater number of its cell-forms and the very soft character of the growth, besides its association with manifestations of the same in other organs. In cases of this nature both testicles are often enlarged at the same time.

Cystic Disease of the Testicle is found as an independent affection, and is also associated with encephaloid, sarcomatous, and enchondromatous conditions of the organ. It is the "hydrated testicle" of Sir Astley Cooper. The disease commonly begins between twenty and forty, though it has been observed at the age of two years.

When existing in an uncomplicated state, cystocele commences in the rete testis, afterwards extending to the body of the testis and the epididymis; is painless and slowly-progressing swelling, which finally extends to the epididymis; is oval in shape, smooth and elastic to the feel, and is generally attended with fluctuation. The tumor often grows to a very great size.

The cysts vary in number and in size. Many are not larger than a pin's point, while others would readily receive a pigeon's egg. Some are simple, others are compound and contain a fluid of different degrees of consistency, in some instances as thin and almost as colorless as water, and in other cases ropy or gelatinous, and containing diverse substances, as dark yellow, granular bodies, a whitish material, blood-corpuscles, fat, and cholesterin. The cysts are surrounded by a more or less dense wall of connective tissue (Fig. 1349), and lined with a tessellated epithelium. The origin of these is ascribed by Curling and Virchow to be the dilatation of the rete testis, while Klebs and others go further, regarding these cavities as the result of an active cell-proliferation in the seminiferous tubules, giving rise to their dilatation, or, in other words, anoma.

DIAGNOSIS.—In advanced cases of cystic disease the tumor may readily be mistaken for hydrocele, or hæmatocele, or encephaloid. From hydrocele it may be distinguished by the greater weight of the tumor, by the absence of translucency, and by its ovoidal form, all of which are characteristics of cystoma. In hæmatocele the opacity, form, and weight exist as in hydrocele, and consequently the differential diagnosis is more difficult; but the obscurity is cleared up by considering that no pain is experienced when the testicle is compressed in cystic disease, and that in the latter affection there is, in its advanced stage, an enlargement of the veins over the surface of the scrotum. A still more satisfactory solution of all doubt will be obtained by introducing a small trocar into the swelling, which, in hæmatocele, will be followed by a discharge of blood and a diminution of the size of the tumor. In cystic disease there may also be some blood discharged on puncturing the tumor, but it will be more florid than that obtained from hæmatocele, and the size of the growth will not be lessened. There is, moreover, in

FIG. 1349.



Cystic disease of the testicle.—From a preparation in the museum of the University of Pennsylvania.

malignant disease of the testicle, some derangement of the general health, a cachexia, together with enlargement of the retro-peritoneal and often of the inguinal glands.

TREATMENT.—Neither local nor constitutional treatment will exert any influence in arresting the growth of the disease. Nothing short of excision of the testicle will answer; and then, if there is no malignant element in conjunction with the cystic disease, there will be a reasonable ground for hope that the affection will not return.

Of sixteen cases in which the testicle was removed on account of cystic sarcoma, all recovered from the operation,* and in five cases of my own there were no deaths. As all of these patients passed out of my observation except one, I was unable to follow their subsequent history. In the one referred to, the disease returned in a few months and terminated fatally.

Enchondroma is often found associated both with cystoma and with sarcoma. When present in cystoma, the cartilage—usually hyaline—exists in small, hard nodules lying in the midst of the intertubular connective tissue, and may attain considerable magnitude. When associated with the malignant deposit in the testicle, the cartilage lies in the midst of the encephaloid material, but separated from it by a surrounding wall or capsule of fibrous tissue. The development of the cartilage in these cases of enchondroma takes place in the intertubular connective tissue of the testis.

Enchondroma may be recognized by its extreme density, elasticity, and weight, its slow progress, and the absence of any unusual sensibility. It may continue for years, when uncomplicated, without occasioning any other inconvenience than that arising from its weight; but should its presence invite a sarcomatous formation,—a very probable occurrence,—the whole aspect of the case will be changed, in consequence of the great activity of the disease.

TREATMENT.—Early excision of the testicle should always be practiced, even when the tumor is believed to be wholly cartilaginous and passive. When this rule is adhered to, we may succeed in getting rid of the disease before the more serious element of malignancy is developed.

Myoma is among the rarest of the tumors of the testicle, and is perhaps in most instances associated with sarcoma or cancer.

It has been described by Rokitsansky and Billroth. It consists of both smooth and striated muscular fibres. Rindfleisch examined a growth of this nature in which there were a large number of nerves running among the muscular fibres. The diagnosis of these tumors is necessarily attended with much obscurity.

Calcareous Depositions in the testicle are occasionally seen. They do not partake of the nature of bone, but are a mere aggregation of granules of earthy salts devoid of animal matter. The calcification sometimes assumes quite an orderly form, being disposed in regularly superimposed layers; at other times there is an entire absence of anything like order, the deposit being a shapeless mass.

The seat of these degenerations may be in the tunica albuginea or in the vaginal tunic in old hydroceles, in the testis, and in the globus minor of the epididymis. Frequently calcareous matter is present in enchondroma and in cystic and fibrous disease of the testicle. Curling believes these earthy deposits to be frequently due to degenerations in previously existing tubercular matter. Such formations are not unfrequently discovered at the bottom of sinuses which remain after tubercular abscess, and through which they have been discharged; indeed, they may serve to perpetuate a fistula of the scrotum. The presence of these earthy masses may be recognized by their extreme hardness and weight.

* Medical Times and Gazette, vol. xl. p. 395.

The treatment of calcareous degeneration must be determined by the nature of the neoplasms with which it is associated.

Fibroma of the Testicle is exceedingly uncommon. There are cases in which, after inflammatory and other changes in the testicle and epididymis, a dense mass of condensed connective tissue will remain, forming quite a noticeable nodule; but these enlargements can scarcely be said to assume the importance of tumors. Cruveilhier has, however, furnished an example of a true fibroma, one before which the glandular tissue of the testis had disappeared, and which in most respects resembled the ordinary uterine fibroid in the arrangement of its fibres. Fibro-plastic or recurring fibroid neoplasms of the testicle have been described by Lebert and Hovard, which, after their removal, soon returned, and proved fatal.

Irritable Testicle.—There are two painful conditions of the testicle which are frequently met with, neither of which is necessarily the result of any local disease in the gland.

These are the hyperæsthetic or irritable, and the neuralgic. The first is characterized by a supersensitive state of the testicles on handling them, often aggravated by walking or by riding on horseback. The undue sensibility is not always limited to the testes, but frequently extends to the cord, and may be attended with such excessive irritability of the genital organs as to occasion great mental distress and despondency. This condition may arise under circumstances diametrically opposite, namely, in young persons addicted to masturbation, or who are given to excessive sexual indulgence, or who suffer from frequent nocturnal emissions; and again in those who, notwithstanding strong and frequent sexual excitement, have resolutely refused to gratify their animal desires. In the first instance the nervous endowments of the genital organs have been exhausted; in the second there is a plethora of the sexual apparatus. The same kind of irritability is not unfrequently witnessed at the period of adolescence, when the supremacy of the reproductive organs is about to be asserted, and also occasionally in persons with varicocele.

In cases coming under the first category the symptoms of indigestion, as feeble appetite, flatulence, constipation, gastric distention, lumbar pains, and great depression of spirits, are prominently present; in those belonging to the second class headache or fullness of the head is complained of.

TREATMENT.—In cases of hyperæsthesia, the habits of the patient must be carefully inquired into. If he is addicted to self-abuse or sexual excess of any kind, the practice must be relinquished, and in order to improve the general health and strength it will be necessary to enforce the shower-bath, of such temperature as will induce no chill, to administer tonics of iron and strychnine, and to insist on an out-door life. The testicles should be douched two or three times a day, and supported in a properly-fitting suspensory bag. When the patient is harassed by seminal emissions, it may be necessary to cauterize the prostatic portion of the urethra.

I have had patients laboring under this morbid irritability of the testicle who have been solicitous to have the gland removed, with a view to escape from the suffering.

Castration, however, is never justifiable under such circumstances, as with judicious management all these symptoms will disappear. When the irritability occurs in persons who lead continent lives, the use of an occasional laxative, of bromide of potassium, and active exercise carried to the extent of fatigue, will usually afford relief.

In cases of this kind marriage proves the most effectual remedy.

Neuralgia of the Testicle, a painful condition of the spermatic nerves, is almost invariably confined to one side, and is met with at all periods of life after puberty. In my own experience the left testicle has been more fre-

quently the subject of the affection than the right. The pain is generally of a lancinating character, shooting both up and down the cord, and is often accompanied by violent retraction of the testis.

The attacks come on usually at irregular intervals, though sometimes they assume a marked periodicity. During the paroxysms the suffering is often exceedingly severe, so that the patient may lose all control over his feelings. After the attack is over, the testicle may return to its natural condition, though it is left in an extremely sensitive state, so that the mere pressure of the clothing against the scrotum becomes intolerable.

In a few instances I have seen the epididymis, especially the globus major, become swollen during the paroxysm, gradually resuming its normal size with the decline of the pain; and in one case of extraordinary severity, and of prolonged duration, the epididymis of the unaffected side became considerably enlarged, though not very tender.

Repeated attacks of spermatic neuralgia tend to produce a subacute epididymitis, with more or less permanent induration.

CAUSES.—The causes of neuralgia of the testicle are often remotely situated from the glands, and among these may be mentioned renal or vesical calculi, the passage of a stone or of gravel along the ureter, urethral stricture, cystitis, and disease of the spinal marrow and its membranes. The disorder may be associated with varicocele, orchitis, and epididymitis; it may also be excited by causes of a more general nature, as gout, rheumatism, disorder of the digestive apparatus, anæmia, excessive venery, and miasma.

TREATMENT.—The successful treatment of a case of neuralgia of the testicle must be based on a just appreciation of the cause.

When the paroxysm is excited in consequence of the passage of a calculus along the ureter, it can be relieved only by the use of such measures as will favor the transit of the concretion to the bladder, as hot hip-baths, and anodynes administered by the mouth, by the rectum, or subcutaneously. When caused by the irritation of crystalline substances formed in the urine before it leaves the kidney, which can be determined only by a microscopic examination of the secretion, the treatment must be guided by the chemical constitution of the crystalline compounds.

If a stone in the bladder exists, its removal can alone secure exemption from the neuralgia. The pressure of varicose veins will suggest the necessity of a suspensory bandage. When a gouty or rheumatic state of the genito-urinary system is believed to underlie the affection, this condition must be corrected by purgatives, iodide of potassium, and colchicum. Should there exist a derangement of the organs of digestion, improvement can be expected only when by laxatives, alteratives, and tonics this derangement has been remedied.

If the sexual appetite has had unlimited indulgence, the patient must put a check on his passions; and when the attacks have been of a periodic character, indicating a miasmatic origin, quinine in full doses, or quinine with arsenic and piperine, will generally arrest the paroxysms. Occasionally, it is said, the painful condition of the testicle can be referred to undue activity of the secretory function of the testis, occasioning a seminal congestion. If this were the case, both testicles should suffer in common, unless it can be shown that unilateral seminal engorgement may occur. I have never seen any case which could be properly referred to such a cause.

Excessive and ungratified sexual excitement will sometimes be followed by neuralgic pain; and for such a condition bromide of potassium can be administered with great benefit.

There are, however, cases in which it is impossible to discover the true causation, and in which our remedies must be directed to the relief of the symptoms as they appear. For this purpose opium, in some of its forms, hyoscyamus, belladonna, and turpentine will be found to yield the best results; and externally, cauterization of the scrotum with nitrate of silver, lotions of laudanum, and poultices of flaxseed-meal and tobacco leaves.

Should a case prove utterly incorrigible under all treatment, and its severity

be such as to render the life of the patient constantly miserable, the question of castration will naturally come up for consideration.

The operation has been frequently performed for the cure of neuralgia of the testicle, sometimes with success, but often without any benefit.

This measure may be resorted to when the usual remedies have been employed without effecting relief; when the paroxysms are very frequent, the pain extremely severe, and the general health beginning to give way; and, last and most important, when there is sufficient reason to believe that the cause is located in the testicle, or in the cord below the external abdominal ring.

Whenever the cause is general, or remote from the testicle, castration is utterly valueless.

Hypertrophy.—Except in marked cases it is difficult to recognize hypertrophy of the testicle, inasmuch as we have no fixed size or weight of the normal gland with which to make our comparisons. The testicles are rarely found to be of the same size, the left being usually larger than the right; or if one appears to be under size, the other by its increased bulk compensates for the deficiency. The size of the testicles varies so much in different persons that I doubt if any practical standard exists. Meckel fixed the weight at four drachms, which Curling thinks too low an estimate. Probably a testicle weighing six or seven drachms might be considered hypertrophied; that is, containing an unusual amount of gland-tissue. Such increased size, however, possesses little surgical interest, as it is no more a morbid condition than an unusually-developed muscle or mammary gland, and cannot be productive of disease.

Atrophy.—There is a form of atrophy of the testicle which is in entire accordance with what is observed in other structures of aged persons, and which may be termed *senile atrophy*.

This is essentially the result of fatty degeneration of the tubuli seminiferi, and often keeps pace with the decline of sexual power.

The nutrition of undescended testes is often much impaired, and marked wasting results. In persons who, in consequence of some defect in the structure of the encephalon, experience little or no sexual impulse, the testicles often remain permanently dwarfed.

Varicocele, when large, causing as it does considerable embarrassment in the circulation through the spermatic veins, will induce softening and alteration in the form of the testes. Excessive venereal indulgence or masturbation may so weaken the sexual power as to cause wasting. Indeed, any cause interrupting the proper supply of nerve-influence to the organs of generation, as pressure on the spermatic cord, paraplegia, injuries of the spine and the cranium, orchitis,—arising either from injury or as a sequel of mumps,—frequently lays the foundation for wasting.

The long-continued use of certain medicinal agents, as iodine, has also the reputation of causing partial absorption of the glands; though this has not been verified in my experience.

In all cases of wasting the epididymis suffers less than the body of the testis.

Except in cases of inflammatory disease of the organ, the physician too often is powerless to improve the nutrition of the testicle. When impaired nutrition results from inflammation, the treatment required will be similar to that employed for the relief of orchitis. Where the demands on the sexual function have been excessive, and as a result atrophy of the testicle is induced, the wasting may be arrested by leading a chaste and continent life.

When there is reason to believe that the atrophy is due to an aggravated varicocele, ligation of the veins may serve to check the progress of the affection. In fine, any cause to which this alteration in the structure of the gland can be referred, and which is removable, should receive attention at once, in the hope that some good may be effected.

Dermoid Cysts.—Among the remarkable affections of the scrotum and testicle which have been occasionally witnessed are cysts containing cartilage, bone, teeth, hair, etc.

Tumors inclosing these organic remains are, of course, congenital. Verneuil* has collected ten cases of these cysts. It was the diagnosis of a tumor of this nature in 1840, by Velpeau, which gave to this eminent surgeon such a reputation for extraordinary sagacity.

Dr. Harris, however, has shown that Velpeau was probably led to the conclusion which he formed by the publication of two operations which had been performed, one in 1826, by M. Fatti, of Braunau, Austria, and the other in 1829, by Professor Wendt, of Breslau, for the removal of scrotal tumors which were found to contain foetal remains. A knowledge of these cases, and the fact that a tuft of hair, in Velpeau's case, protruded through an ulcerated opening in the scrotum, would contribute very greatly to remove the obscurity of such a tumor and to lessen our surprise that its true nature had been properly conjectured.

Various theories have been advanced to explain the presence of foetal remains in so unusual a locality.

Velpeau and others have thought that these organic matters were originally inside of the abdomen, in close relation with the testicle, and that they descended along with the latter during its migration to the scrotum. The view entertained by Geoffroy Saint-Hilaire is probably the correct one, which regards such remains as parasitic, being aborted or imperfect germs which are included in the body of another or perfect organization.

The diagnosis of such a tumor would rest upon its congenital origin, upon the ability to discover something which, from its resistance and form, would convey the idea of bone, and, if ulceration has taken place, upon the probable appearance of hair or other foetal structures in the opening. Excision of the entire tumor, including the testicle, has generally been found necessary.

Entozoa are rarely found in the testicle. Only two instances have been collected: one in the Hunterian Museum at Glasgow, and the other in the museum of the College of Surgeons, Edinburgh, in both of which a Guinea-worm (*Filaria medinensis*) was attached,—in the one case to the lower end of the vas deferens, and in the other to a tumor removed from the scrotum.†

Castration.

Castration is a very ancient operation. In the East it is performed as a punishment for state offenses, also to prepare a class of servants suited to the service of an imperial residence. The word eunuch is derived from two Greek words, *εὐνή*, a bed, and *ἔχειν*, to have or to keep, and thus signifies one having charge of the beds of the women.

Castration was the natural consequence of the system of polygamy so prevalent in the East. In Greece, until the Byzantine period, the practice was quite uncommon. In Rome, under the emperors, many eunuchs were kept. In Italy, at one time, castration was practiced in order to secure a certain quality of voice, the soprano. At the present day eunuchs are found chiefly in Mohammedan countries. There is at Moscow, Russia, a community of eunuchs, who are jewelers by profession, and who add to their numbers by the purchase and mutilation of children. At Tambov and the principal villages around Moscow, it is said, there are not less than twenty thousand of these fanatics.

Though castration done early, as a rule, has the effect of materially changing both the physical and the moral constitution of the individual, causing an arrest in the growth and vigor of the body and of the beard, producing also a character full of intrigue and deception, there have been eunuchs who were

* Archives Générales de Médecine, 5me sér., t. v. et vi., 1855.

† Curling on the Testis.

by no means deficient either in energy or in ability. Bagoas, the Persian minister, was a eunuch, and also a soldier of Artaxerxes Ochus. He plotted against his master, and finally poisoned the king and several of his sons, but was himself put to death by Darius Codomannus, whom he had been instrumental in elevating to the throne of Persia. Philetærus, king of Pergamus, and Narses, the Byzantine general, were also, though eunuchs, men of more than ordinary ability.

We read in the New Testament of men being made eunuchs for the kingdom of heaven's sake; that is, men had voluntarily sacrificed their manhood in order that all temptation to fornication and adultery might be removed.

The practice probably grew out of a wrong interpretation of the injunction, "If thine eye offend thee, pluck it out," or "thy right hand, cut it off." In all enlightened countries the removal of the testicles is resorted to only on account of disease.

OPERATION.—The hair being shaved from the pubes and scrotum and the patient placed in the recumbent position on a narrow table and brought under the influence of an anæsthetic, an incision should be made in the whole length of the tumor, beginning immediately below the external abdominal ring, and extending to the inferior boundary of the scrotum. The surgeon must be careful, even in large growths, not to include too much of the integument in his incision, as the contraction of the dartos will occasion a great deal of shrinkage. The coverings of the testicle and cord being divided, the gland is to be drawn out of the scrotum by traction, breaking up the cellular attachments with the finger, and cutting those which do not readily yield with the knife.

In thus dissecting out the tumor the septum must not be injured, nor the penis, both of which should be held out of the way. The testicle being now divested of all its coverings, the cord is to be cleared of its muscular and fascial envelopes, and the vas deferens separated from the other constituents. A pin should now be passed between the duct and the other constituents of the cord which contain the blood-vessels, and the latter secured by placing a ligature round the extremities of the pin, after the manner of the twisted suture, when the cord can be severed below and the testicle removed. (Fig. 1350.)

Some surgeons object to this mode of dealing with the cord, and prefer drawing out the spermatic and deferential arteries and tying them alone, alleging that, by including the components in mass, unnecessary pain is given, and that there is danger of inflammation extending into the abdomen.

Though I invariably resort to this plan, I have never heard patients complain of any unusual pain, nor have I witnessed any unusual symptoms follow the practice. The operation is much more quickly done, gives a complete control of the cord subsequently, and the ligature admits of being removed at any time, at the pleasure of the operator, by merely withdrawing the pin. Generally, this can be done safely on the third or fourth day after the operation.

There is another reason which may be given for this mode of securing the vessels of the cord. The artery of the vas deferens is very small, difficult to find, and often does not bleed at the time of the operation, thus escaping observation. If allowed to remain without being secured, hemorrhage will most certainly follow after the wound is closed. By the use of the pin this is made impossible.

Should the surgeon prefer to tie the vessels separately with ligatures, a

FIG. 1350.



Mode of securing the vessels of the cord.

thread should be carried through the connective tissue of the cord before dividing it, so that in the event of its retraction within the inguinal canal he shall have the means of again drawing it out. There is a strong tendency in the spermatic cord, after being divided, to draw up; due partly to its elasticity and partly to the contraction of the fibres of the cremaster muscle.

Benjamin Bell relates the cases of two patients who perished from hemorrhage in consequence of this retraction taking place before the vessels were tied.

The cord being disposed of, a careful and diligent search must be made for every bleeding vessel in the scrotum, and these, which often amount to six or seven, tied. Wherever a little clot is seen, let it be scratched off, as it often masks the orifice of an artery which will require a thread. This injunction of the operation should be strictly obeyed, as any neglect in its observance will probably subject the operator to the annoyance of reopening the wound on account of subsequent bleeding.

After the ligature of the arteries the sides of the wound are to be brought together by interrupted sutures, the stump of the cord being included between them, and the parts covered with a piece of lint moistened with carbolated oil, and supported either on a cushion or in a sling formed by a broad strip of muslin, passed beneath the scrotum, and its ends fastened to a band surrounding the body.

The contraction of the dartos, serving to keep the surfaces of the wound in close contact, contributes greatly to rapid healing, and thus we find that, if no complication occurs, the parts are well united in three or four days.

The possibility of a hernia co-existing with a diseased testicle must not be overlooked in castration, as in such an event the intestine or omentum might be wounded through negligence. Should a hernia be present and recognized before the operation is begun, it must be reduced, and its retention, after the patient recovers, be maintained by the pad of a truss, applied over the inguinal canal and external ring.

Usually the operation of castration is attended with little danger, except when it is found necessary to extend our incisions into the inguinal canal, in which case the patient is exposed to the risk of peritonitis. Indeed, when the cord within the canal is involved, the propriety of any operation is exceedingly questionable.

When death has followed castration, it has been due to erysipelas, pyæmia, secondary hemorrhage, or peritonitis.

DISORDERS AFFECTING THE USE OF THE GENITAL FUNCTION.

There are three conditions affecting the genital organs which are deeply concerned in disturbing the mental peace and happiness of many persons.

They are *impotence*, *barrenness* or *sterility*, and *spermatorrhæa*.

Impotence.

Impotence may arise from both physical and mental causes. It may be either real or fictitious. By the term impotence is meant an inability to perform the sexual act. It does not by any means imply a defect in the seminal secretion, although this may be the case.

The conditions necessary for the consummation of the sexual act are an erection sufficiently firm for the introduction of the male organ into the vagina of the female, and the ejaculation of the seminal fluid. The physical causes which defeat sexual congress on the part of the male, and thereby render an individual impotent, are:

1st. *Absence of the penis*,—an exceedingly rare defect.

2d. *Diminutive size of the penis*, either natural or acquired (as in some cases of exstrophy of the bladder, or from amputation for disease), may render connection impossible; or the disqualification may be due to the disproportion

between the size of the male organ and that of the vagina being such that the friction necessary to produce venereal orgasm cannot be obtained.

It must not, however, be inferred that disqualification for copulation depending on the deficient length of the male organ implies sterility. The power to deposit the semen, if only between the labia minora, is still an act of potency, and may prove a fruitful connection. There are numerous cases recorded in which pregnancy has taken place with an unbroken hymen. I am cognizant of a case in which a woman, who has had several children, has repeatedly declared that in consequence of premature ejaculation the vagina had never been entered. Her husband confirms this assertion.

3d. *Congenital malformation and malposition*, as hypospadias, epispadias, incurvations, and phimosis, may also cause impotence, by interfering with the proper projection of the semen.

I have seen, however, a case of hypospadias in which the urethra terminated more than an inch short of the glans penis, but which did not in the least interfere with either potency or fruitfulness of intercourse, as the individual had a large family of children.

In a case of very tight phimosis, I once operated successfully in order to remove a mechanical obstruction to the discharge of the semen.

The accidents which may occur to the undescended testes are calculated to induce impotence.

4th. *Acquired alterations of structure* are a very common cause of impotence. Thus, urethral fistulæ opening on the perineum, or even through the spongy portion of the canal, will serve to divert the semen from the proper course. An enlarged prostate or a myo-fibroma, either by mechanical pressure or by changing the direction of the orifices of the ejaculatory ducts, may prevent the transmission of the seminal fluid along the canal, or cause it to pass into the bladder. Stricture of the urethra frequently offers an insurmountable obstacle to proper ejaculation, and a urethral calculus may act in the same manner. Inflammatory or cartilaginous deposits in the cavernous bodies of the penis, or cartilaginous degeneration of the septum pectiniforme, may produce vicious curvatures in the virile organ, or may induce such structural alteration that while the posterior portion of the penis is capable of erection the anterior part remains flaccid, defeating all attempts at penetration.

Again, imperfect turgescence of the male organ amounting to impotence is not unfrequently witnessed after attacks of syphilitic orchitis, carcinoma of the testicle, exhausting disease, masturbation, and abuse of the sexual organs; and in my own observation this sexual incompetence among young men is greatly on the increase, at least among the residents of large cities.

It is said that in Asiatic countries, where polygamy and concubinage prevail, early impotence is much more common than among Occidentals,—a statement which has been corroborated by the observation of travelers.

5th. *Cerebro-spinal causes*.—Injuries of the head, especially those involving the cerebellum, are productive not only of atrophy of the testis, but also of the loss of virile power. Larrey has particularly noticed this sequence, and cases corroborating the observation have been recorded by Gall, Smyth, Fisher, and others. Apoplexy, epilepsy, tumors, and softening of the brain are often accompanied by loss of erectile power, and a similar disability is frequently witnessed in the idiotic from imperfect development of the generative organs. Severe concussions and lesions of the spinal marrow may also be followed by impotence.

Any cause which tends to induce nervous exhaustion is sufficient to suspend temporarily, and sometimes permanently, the ability to perform the sexual act. It is thus that the intemperate use of tobacco and excessive venereal indulgence lay the foundation for impairing or destroying virility.

6th. *Disease of adjoining portions of the genital organs* will also, by absorbing the integument of the penis, and encroaching on the latter, render copulation impossible; in illustration of which may be mentioned a large single or double hydrocele, elephantiasis of the scrotum, and voluminous herniæ.

7th. *Oxaluria* is sometimes a cause of impotence,—a fact first noticed by Golding Bird; and when cases present themselves in which the power of erection is lost, and there appears no obvious reason for the disability, the urine should always be examined, especially if symptoms of indigestion are present.

In addition to the above causes, temporary impotence not unfrequently is the result of feeble health or physical exhaustion.

TREATMENT.—Some of the conditions which have been enumerated as producing impotence are irremediable, while others admit of being removed. Thus, in the impotence arising from hypospadias, the restoration of the imperfect urethra by a surgical operation is the remedy. When it is caused by phimosis, circumcision must be performed; and if due to narrowing of the urethra by stricture, the normal calibre of the canal is to be restored by dilatation, with or without incision. Syphilitic impotence is sometimes removed by a course of mercury or iodide of potassium.

Premature emissions, depending as they so frequently do on an excessive irritability of the nerves of the prostatic portion of the urethra, require gentle cauterization, the use of alkaline diluents, gentle laxatives, and a course of strychnia and iron.

Disability in consequence of hydrocele or hernia is to be removed in the former affection by tapping, and in the latter by reduction, when feasible, and the use of a truss.

Impotence from oxaluria requires the administration of nitro-muriatic acid, and a properly-regulated diet, consisting largely of vegetable and farinaceous articles,—except rhubarb and tomatoes,—with milk, and only a moderate amount of meat; and when arising from nervous exhaustion or general constitutional weakness, rest, change of air, relief from all the cares, exactions, and anxieties of business, substantial food, and a course of strychnia, iron, and phosphorus.

There are several agents which possess a certain degree of aphrodisiac power, some of them in virtue of the local irritation which is provoked by their use, as the tincture of cantharides and phosphorus; and, in cases where the erections are feeble, they may sometimes be employed to give a temporary energy to the virile organ. Electricity or electro-galvanism may also be used with a view to improve the nervous supply of the muscular apparatus of the genital organs, one of the electrodes (positive) being placed over the lumbar region or over the cord, and the other at the root of the glans penis, also over the perineum, the interrupted or faradaic current being preferable.

Pseudo-Impotence, or Fictitious Impotence.—In many instances of impotence the causes are purely of a mental or moral character; and there is no other class of patients requiring such delicate and adroit management. Success will depend on a due appreciation of the interdependence which subsists between the mental and the physical. Among these causes may be mentioned want of confidence in the ability successfully to effect coition; and if the first encounter should not be crowned with success, the second is always undertaken in a state of trepidation and anxiety, and is likely to end similarly; or the failure may result from an over-excitement which will not abide the delay incident to the natural obstacles to the consummation of the sexual act. Under these circumstances nothing further will be required than a few words of encouragement from the professional confidant, assuring the troubled spouse, in the first case, that confidence and potency will come with better acquaintance, and, in the second case, that time, exhausting the redundancy of erotic excitement, will remove the disability.

Want of response, or sexual indifference on the part of the female, may effectually repress all desire for connection, and can be remedied only by the wife feigning what is really not experienced. Want of affection, disgust at some act, or the escape of an unfortunate expression, may all prove instrumental in defeating copulation.

A case was communicated to me in which, in consequence of the homely

face of his wife, the husband could only by concealing her head have a successful intercourse. In other instances, in the absence of personal attractions, men have been compelled, in order to effect copulation with a companion, to think of some other woman.

Men have confessed to me that the consciousness of being unfaithful to the lawful bed has rendered them utterly impotent in the company of a strange woman.

Sterility.

Sterility, or an incapacity to beget children, depends, *first*, on some defect in the spermatic fluid; *secondly*, on some functional or inorganic inability to deposit the sperm within the vagina.

First. The constituents of the semen necessary to fecundation are spermatozoa. These are much oftener absent than is generally supposed. Until the age of puberty the secretion of the testes is devoid of zoösperms, and again in advanced life, when the sexual powers are on the decline, these bodies, losing first the tails and finally the heads or the cells, begin to disappear.

Nevertheless, there are some persons whose fecundating power remains to a very late period of life. A patient once under my care begat children at eighty years of age. Cato, the Roman censor, had a son born to him at eighty. Ladislaus, King of Poland, had two sons after the age of ninety. Pliny states that Masinissa had a son born to him after eighty-six. Pallavicini, on the authority of Savonarola, had a son at one hundred years of age; and an instance is given by Lemnius of a man who, at the age of one hundred, married a young woman, by whom he had several children.

These are, however, rare exceptions to the general rule, that after seventy the potency of the male is greatly lessened, and with it the power of fecundation.

The secretory power of the testes may be so exhausted by sexual excess that the zoösperms entirely disappear. Such a condition, however, would not justify the conclusion that an individual presenting so important a defect in the spermatic fluid was permanently sterile, as a few weeks of continence might be sufficient to restore the functional perfection of the glands. In progressive atrophy of the testicle, either as a result of inflammatory changes or from the want of a sufficient amount of blood, the spermatozoa disappear. Indeed, the same is true in all cases of syphilitic, strumous, or malignant disease of the testes. The testicle which remains sound is, however, not necessarily disabled by the disease of the affected one.

Malposition being generally associated with imperfect development of the testes, the secretion of these glands is very frequently found deficient in an impregnating fluid. Nevertheless, while this is the rule, there are not wanting instances of cryptorches having begotten children. If one testicle is in the scrotum, and sound, though the other may never have descended, the individual is not necessarily sterile.

Secondly. Inability to deposit the sperm within the vagina (*dyspermatism*) may result from various causes. The penis may be absent either congenitally or accidentally, in which case sterility must follow. The same will be true if the excretory ducts of the epididymis have been occluded by inflammation, as sometimes happens after a severe epididymitis. A gentleman of this city, whose wife was having children in quick succession, was attacked with an unusually severe epididymitis of the left testicle, followed in a few days by an inflammation of the right epididymis, each of which was left with a hard knot in the globus minor, which remained unresolvable. The spermatic fluid contains no zoösperms, and, though the patient is entirely potent, intercourse has proved fruitless ever since his recovery.

This corresponds to what has been observed by Gosselin, who examined the sperm in twenty persons who had suffered from double epididymitis, and in all the spermatozoa were absent from the semen. Only two of the patients, however, was he able to keep under prolonged observation, and in

these, as the induration of the epididymis disappeared, the zoöperms were again found in the spermatic fluid.

Injury to the ejaculatory ducts inflicted in the operation of lithotomy, not an uncommon occurrence, may also interfere with the passage of the semen.

Another source of inability to introduce the semen into the vagina is stricture of the urethra, particularly when the canal is so coarctated as to offer a serious mechanical obstacle to the passage of the spermatic fluid. Many persons are rendered incapable of fruitful connection by this cause, the semen dribbling away for hours after intercourse, instead of being discharged *per saltum*, the ejaculation being delayed until the erection has subsided. Any mechanical obstruction of the urethra, as the presence of a polypoid growth, or the impaction of calculus, may be followed by a like result.

The loss of the ejaculatory power constitutes another cause, under the head of *dyspermatisms*, for unfruitfulness. It is the act of ejaculation taking place at the culmination of the sexual orgasm which propels the semen in jets from the urethra into the vagina of the female. Its failure to occur necessarily involves the absence of a condition essential to impregnation.

Spermatorrhœa.

Spermatorrhœa, or the flow of semen, may occur under very different conditions. It may be voluntary, as in self-abuse or masturbation; or involuntary, as in diurnal or nocturnal pollution; and it may consist in a passive loss of the secretion without the consent of the will, and without ejaculatory pleasure.

CAUSES.—The causes of spermatorrhœa are both *physical* and *somatic*.

The secretion of the testes after puberty is not an intermittent process, but a constant one. Except, however, under excitation, the spermatic fluid is very slowly formed, and it is only when the stimulus of excitement is present, and particularly when the desire for connection remains ungratified, that the seminal secretion accumulates to an extent which tends to provoke frequent ejaculations during sleep. As the sexual organs are greatly influenced by the brain, any impressions of a lascivious nature are calculated to induce an exaltation of the secretory functions of the testicles. Thus, when the rein is given to lewd thoughts, to impure reading, or to the contemplation of sensual exhibitions, the seminal passages become surcharged with the spermatic fluid, the plethora from which induces emission. Lascivious dreams, which are so frequently the immediate excitants of ejaculation, are in many instances the direct result of mental impressions made during waking hours.

Among the *somatic causes* are inordinate sexual indulgence, which, by making frequent draughts on the testes, and attended as it is with a constant repetition of nervous shocks, finally gives rise to a preternatural irritability of the entire sexual apparatus, which leaves it extremely impressionable to reflex influences, whether derived from the mind or from the body. In this condition an erotic thought, the near approach of a female, or the friction of the clothing against the glans penis is sufficient to produce an involuntary ejaculation of the seminal fluid.

Again, both unusual secretion and expulsion of the semen may be provoked by irritation in contiguous organs, which, though not directly connected with the testicles, are, nevertheless, indirectly related to them by nervous lines of communication. Thus, rectal disease, as hemorrhoids, fissure of the anus, and ascarides, cause involuntary pollutions by reflex action. In the same manner cystitis, vesical calculi, stricture of the urethra, and inflammation or congestion of the prostatic urethra induce ejaculations.

By far the most common cause of spermatorrhœa, however, is *masturbation*,—that is, friction by the hand until the venereal orgasm is reached. This vice is common in both sexes, but much less so in females than in males. The former are less under the influence of animal passion, and the native modesty peculiar to the sex renders the incitement to such indulgences, with

very few exceptions, very feeble indeed, and not often self-evoked. The dominance of the sexual appetite in the male crops out very early in life, erections in young children being matters of common observation. Nurses often lay the foundation for future masturbation by handling the sexual organs of male children with a view to prevent fretting or restlessness. Boys acquire the habit of self-abuse from their associates at school, and not unfrequently from their seniors. The irritation occasioned by a tight prepucæ or phimosis is frequently alleged to be another exciting cause of this vice. The practice is not confined to man. Many of the lower animals are equally addicted to a similar habit, as the monkey, the goat, etc.

Injuries of the head are occasionally concerned in the production of masturbation. This was notably so in the case of a celebrated clown, who died in the insane department of the Philadelphia Almshouse. Utterly devoid of shame, he would constantly indulge in the practice in the most public manner. The habit began shortly after a blow received on the back of the skull from a slung-shot. The skull after death was found to have a marked depression immediately below the superior semicircular ridge of the occipital bone.

When the habit of masturbation has been once acquired, it exercises the most despotic tyranny over its victim, so that even when he is conscious of the evil and dangerous consequences sometimes resulting from the continuance of the vicious indulgence, so imperious is the passion that there is not sufficient power of will left to refrain.

It must not be forgotten, however, that masturbation and spermatorrhœa are sometimes symptoms rather than causes of disease, and that, as Sir James Paget has very forcibly said, "even among the insane there are many of whom it would be truer to say that they masturbated because they were insane, than that they became insane because they masturbated."

Interesting statistical proof of the relations between organic disease of the nerve-centres, masturbation and its attendant evils, and actual criminality, may be found in the report for 1875 of the surgeon of the Eastern State Penitentiary, Dr. J. Wm. White, to the Board of Inspectors. The physical and mental condition and family history of those convicts known to be confirmed masturbators were compared with those of the rest of the prison population. Of all those in confinement, 58 per cent. were received in impaired physical or mental health, or were considered likely to develop disease from inherited defect, while of the onanists, 85 per cent. were the subjects of mental or physical disease at the time of admission, or were hereditarily predisposed to such disease. Thirteen per cent. of the entire population of the prison had been convicted of crimes of an emotional character,—“crimes of the passions;” among the masturbators, 56 per cent. had been guilty of crimes of this class. The deaths from diseases of the nerve-centres were four times as frequent among these prisoners as among those guilty of crimes against property. Twenty-five per cent. of all the prisoners had been convicted more than once; 46 per cent. of the onanists had been reconvicted, that is, approached more or less nearly to the class of habitual criminals.

The practical deduction from these facts, which are considered at length in Dr. White's report, is that we should be guarded in our prognosis and treatment of the nervous affections so frequently found associated with masturbation and spermatorrhœa, and should not err by attributing to the latter undue etiological power, when the truth is that they are often only effectual in exciting disease when there already exists a powerful predisposition to it. The careful surgeon, therefore, before commencing the treatment of a case of this character will search for any possible constitutional defect,—inherited or acquired,—examining especially the condition of the nervous system, and endeavoring by every means in his power to eliminate the possibility of mistaking a local manifestation of general disease for the disease itself.

The *symptoms* which follow abuse of the sexual organs are involuntary emissions occurring during sleep, occasioned generally by lascivious dreams.

These are repeated sometimes for several consecutive nights, or even twice in a single night. If allowed to continue unchecked, they are liable to occur either entirely without erections or with very feeble erections during the night, and even in the course of the day, on the slightest provocation, and finally may terminate in a spermatorrhœa, the spermatic fluid escaping during defecation or in other straining efforts, unattended by any ejaculatory orgasm or pleasurable sensation. The general health at length begins to fail. The patient loses his appetite; is annoyed with symptoms of indigestion, a flatulence, uneasiness after eating, abdominal distention, and costiveness; loses flesh; grows weary on taking even moderate exercise; has a languid, dull appearance; the skin becomes discolored under the eyes; the vision is often impaired; he complains of palpitation of the heart, pains in the loins, and a sense of great fatigue, especially after an emission. The moral effect of the disease is also very noteworthy. The patient becomes greatly depressed in spirits, melancholy, avoids society, has a shy, downcast look, blushes, is absent-minded, with defective memory, and is often disqualified for the pursuit of any business. Not unfrequently the individual thus affected is rendered practically impotent, the testicles become soft, and the scrotum is relaxed and elongated.

TREATMENT.—The treatment of spermatorrhœa is prophylactic and curative. To prevent the formation of the habit of masturbation in a boy should be a matter of the first importance. With this view a careful watch should be kept over nurses to see that they do not handle the organs of the child. A long prepuce should be removed. Boys, especially if of different ages, should not be allowed to sleep together. When there is reason to believe that a lad has commenced a practice of this nature, he should be taken at once into the confidence of the male parent or the family physician, and, by appealing to his noblest and best qualities, an endeavor should be made to strengthen his feelings of self-respect and manliness, and to enforce with tenderness and kindness the obligation to live a pure and chaste life. Much more will be gained by a course of this kind than by one which appeals to his fears. Young children who have been educated into the habit can only be restrained by watchfulness, correction, and, if necessary, by confining the hands in such a manner that they shall be unable to finger the parts.

There are many persons whose lives are perfectly pure, and who are not chargeable with any secret sexual vice, in whom, from the possession of strong sexual powers, there occurs an occasional nocturnal seminal ejaculation. This may happen once or twice a week, and yet indicate nothing more than an unusual plethora of the spermatic receptacles; indeed, it may be deemed purely a salutary act.

Nevertheless, to persons who are ignorant on the subject of sexual hygiene, or who, perchance, have had the misfortune to read the circular of some unprincipled charlatan, these periodical emissions assume the greatest importance, and awaken fears with reference to the probable loss of manhood, which seriously interrupt their happiness and welfare. Here the duty of the physician is first to assure the patient that his apprehensions are groundless, and that his case is not one of disease at all. This will restore his peace of mind, and remove at once that anxiety and apprehension which are calculated to perpetuate the self-pollution. These are the cases which are sometimes advised to indulge occasionally in sexual intercourse; and there is no objection to this if it is legitimate, and where a proper marriage is practicable, its consummation will be the surest plan of getting rid of this kind of seminal incontinence. No one, however, can justify an act of fornication on the ground that the sexual appetite craved indulgence; and all teaching to the contrary is in direct contravention to the moral law. To advocate an opposite doctrine would be to give the leash to the worst passions of men, and to sweep away the most effectual safeguards to purity and virtue. When circumstances prevent marriage, the individual must be instructed to lead an active life, to avoid the contemplation of all subjects

calculated to appeal to the animal passions, to use a plain, unstimulating diet, to keep the bowels regular, and to rise after the turn of the night and empty the bladder. Such a course will confine these occasional emissions within harmless limits.

It is more particularly with cases where self-abuse has been long practiced that we have to do. Patients who apply for relief under these circumstances generally readily confess their weakness. Of course, if masturbation is practiced it must be abandoned, as a preliminary measure to all other treatment; though in most instances where professional counsel is sought the patient has long ceased to indulge in this habit. He is suffering from the effects of nervous exhaustion; the digestion is disordered; voluntary erections are feeble, or perhaps impossible; nocturnal pollutions are very frequent, and he is in a condition of great mental gloom and despondency.

The treatment must be general and local, both of which will be greatly promoted by administering to the moral sense of the patient, giving him all reasonable assurance that the case is one which admits of relief, and then exacting a radical change of life and habits. The mind must be occupied with pure and elevated subjects of thought; consequently, the books which the patient reads, the companions with whom he associates, the occupations in which he engages, and the amusements in which he participates should all be of such a character as to appeal to the best qualities of the man.

The medical treatment should be directed to the correction of the digestive organs, to the removal of all sources of reflex irritation of the generative organs, and to the imparting of tone and vigor to the system at large. In fulfilling these indications, all articles of food calculated to oppress or tax the stomach must be discarded. Generally the diet which can be used with the least inconvenience consists of broiled or roasted meat, as beef, mutton, or game, good bread, eggs, white potatoes, rice, or milk, the digestion of which will be rendered more easy by taking at each meal five grains of pepsin. The patient should be much in the open air, at the same time avoiding all fatigue, in order that the nervous energy may not be unnecessarily exhausted. To these may be added general and local bathing.

Not unfrequently a change of scene will exert a salutary influence, especially when there is much depression of spirits. As a further means of improving the general health and restoring nerve-power, tonics can be given with great advantage, as iron, quinine, strychnine, and phosphorus, also the mineral acids, and, where there is loss of flesh, cod-liver oil. It will be of the first importance to ascertain if there exists any local irritation in contiguous organs which may be reflected injuriously on the spermatie passages and thus provoke involuntary ejaculation of the seminal fluid. It may be that the urinary secretion will be found loaded with urates, phosphates, or oxalates; and this condition must be corrected by the use of the infusion of a bitter tonic, as gentian, with the addition of nitric or nitro-muriatic acid. If the bowels are sluggish and the fæces linger in the rectum, their daily dislodgment must not be overlooked. I have alluded to the necessity of emptying the bladder during the after-part of the night in cases of spermatorrhœa. This is an *indispensable* part of the treatment. The night-urine, in consequence of the inactivity of the cutaneous glands, is much more highly charged with solid matters than the urine which is passed during the day, and, consequently, when the bladder becomes somewhat distended with this concentrated secretion during sleep the irritation which follows is propagated along the nerves to the muscular apparatus concerned in the expulsive orgasm, and an emission follows.

It is this *reflected* irritation which induces morning erections.

Many times have I succeeded in arresting nocturnal pollutions by urging the necessity of emptying the bladder at *two or three o'clock* in the morning, as it is during this part of the night that emissions are likely to occur. This precaution should never be neglected in cases of spermatorrhœa.

Besides the irritation transmitted from the bladder, there is not unfre-

quently another, located in the prostatic urethra, which is equally capable of causing emissions. Its existence is readily recognized by passing a soft bougie along the urethra: the extreme sensibility of this part of the canal will be discovered as soon as it is reached by the instrument. As it is in the prostatic urethra that the ejaculatory ducts empty, all morbid impressions on its mucous surface are quickly transmitted thence to the seminal vesicles. Hence the necessity of early removing any vascular fullness or undue sensibility which may exist in this section of the urethra by proper local applications, the best being the nitrate of silver, varying in strength from forty per cent. to the pure salt. The application is most conveniently effected by the instrument of Lallemand (Fig. 1351), which is a catheter-shaped canula, containing a stylet with a spherical termination, and near the end of which

FIG. 1351.



Lallemand's urethral porte-caustic.

is a little cup for the reception of the crayon of caustic; this, after being charged and carried down the urethra to the prostatic part of the canal, is protruded and rotated two or three times in quick succession, then drawn into the canula, and the instrument removed.

This may be repeated two or three times—never more—at intervals of ten days. It is usually followed by some smarting pain and scalding urine. Occasionally, though quite rarely, the cauterization is succeeded by retention of urine; but this soon yields on taking a hot hip-bath and injecting into the bowel thirty drops of laudanum in a little starch-water. The caustic application is also sometimes followed by a slight bleeding from the urethra; but this soon subsides spontaneously.

After cauterization it is quite common for the patient to have a temporary increase of the emissions; but these soon subside, and in many cases they are permanently prevented. There is no doubt that much harm is done by the indiscriminate application of caustic agents to the urethra. They may be followed by an irritable bladder, by cystitis, and by epididymitis. The cases where cauterization does good are those in which there is extreme sensibility of the prostatic urethra, and are generally met with in *chronic* examples of the disease.

The power possessed by the bromide of potassium of lowering the sensibility of the spinal cord and brain renders this drug valuable for the purpose of procuring sleep and preventing dreams, and thereby diminishing the irritability of the sexual organs.

Different mechanical appliances have been devised to stop the nocturnal emissions, some of which are designed to prevent the patient from occupying an unfavorable position during sleep,—as on the back. With this view it has been directed to wear a long towel round the body when retiring to bed, with a knot so placed as to rest directly over the spine and so cause sufficient discomfort, in the event of the dorsal position being assumed, to awaken the patient and compel him to turn upon the side. Rings having teeth somewhat sharp have also been worn over the penis. These contrivances are placed upon the organ in its flaccid state. If an erection occurs, the pain caused by the teeth pressing into the integument will be sufficient to rouse the person from his rest before ejaculation. With the same object

in view, perineal trusses are sometimes worn, which, by pressing firmly in front of the anus, are supposed to offer an obstacle to the escape of the spermatic fluid.

Trousseau has commended the use of an olive-shaped metallic compressor, to be worn in the rectum during the night, so adjusted as to make pressure against the prostate body and the seminal vesicles.

When there exists a passive flow of the spermatic fluid,—an uncommon condition,—or when it escapes during defecation, much benefit will be derived from the free use of strychnia and the fluid extract of ergot, conjoined with the cold hip-bath and electricity.

In aggravated cases of spermatorrhœa, which have persisted in defiance of all remedial measures, the surgeon will sometimes be consulted with regard to the propriety of castration. I can conceive of no circumstances justifying such a mutilation. The operation has been done without producing any alteration of the mental symptoms: indeed, the very consciousness of being emasculated has precipitated the unhappy victim into a still deeper despondency, and even forced him to take refuge in self-destruction.

There is another question upon which the surgeon will be consulted, namely, the propriety of a person marrying whose sexual powers have been greatly enfeebled by long-continued spermatorrhœa. No one under such circumstances should be encouraged to assume a relation of this kind. It would only tend to further exhaustion, and consequently lessen the prospects of recovery. Patients should not be deceived in a matter so vital to human happiness; for while many persons whose virility has been greatly enfeebled do recover sufficiently to consummate the sexual act, there are many others who are never able to meet even the most moderate exactions of marital life, and it is no exaggeration to say that when the potency of the genital organs has once been seriously impaired by secret abuse the original vigor of function will never be regained.

Congenital Defects of the Bladder.

Under this head are included absence of the bladder, supernumerary bladders, malposition of the bladder, and exstrophy.

Absence of the bladder is an exceedingly rare occurrence, only a few instances of this nature having been observed. When the defect exists, the ureters open into the urethra, the rectum, the vagina, or at the median line of the body.

Lieutaud gives a case in which the ureters, much increased in size, opened close to the orifice of the urethra and immediately below the pubes.* This person was a man thirty-five years of age. A second case is given by Binsinger, in which the bladder was absent and the ureters opened into the urethra.† Richardson mentions an instance in which the ureters terminated in the rectum. The lad, at the time seventeen years old, had never passed any urine through the urethra, and hence the inference was fair that no bladder existed. The only inconvenience experienced was a troublesome diarrhœa.

Camper has collected five similar cases, and Klein one.‡ Several cases are recorded by Haller in his Physiology in which the ureters terminated in the bladder. Schroeder has given examples of the same kind. I was consulted in a case of a similar nature in a lady living in the northern portion of Pennsylvania.

These abnormalities are sometimes found associated with other irregularities of development, as in the case reported by Dr. Raphael, of New York, in which, in addition to the absence of the bladder, there were imperforate anus, undescended testicles, and absence of the colon. The ureters ter-

* Hist. Anat. Med., Liber primus, obs. 1361. Cyclopædia of Anatomy and Physiology.

† Obs. Med., 24, cart. 2. Cyclopædia of Anatomy and Physiology.

‡ Rachit. Congenit. Nov. Eph. ac Nat. Cur., vol. i. obs. 33.

minated in a sac, which protruded at the umbilicus, and which contained the intestine. This example of monstrosity died nine days after birth.

A case somewhat similar to the above was observed by Dr. Todd,* of London. The subject of the abnormality was a female foetus, which survived a few days. The ureters opened, one on each side of the pubes, through the abdominal parietes. Only about one inch of the large intestine existed, and the lower portion of the rectum and the expansion of the oblique muscles of the abdomen were absent.

Supernumerary Bladders.—Many of the cases reported to have been of this character were merely examples of the sacculated bladder, and, of course, deficient in muscular fibres. Even in those cases where the coats of the supernumerary bladder were complete, the irregularities might, in most instances, more properly be considered as instances of multilocular bladders, as the pouches all opened into a common reservoir. This is probably the explanation of the case mentioned by Professor Scibelli, of Naples, in which three bladders are described as being present; two, however, were continuous with the ureters, and were possibly dilatations of those ducts rather than additional bladders. In other cases the bladder was divided into two nearly equal halves by a partition, either with or without an opening for lateral communication. Angelo Scarenzi's case belonged to the first category, and the one of Blasius to the second, a ureter opening into each compartment. Bromfield describes a similar conformation, and Morgagni has collected others of a like character. Fantoni, in his *Anatomy of the Human Body*, has described a case which was probably one of multiple bladders. The most remarkable of all examples of a plurality of urinary bladders is that recorded by Molinetti† of a woman who had five bladders, five kidneys, and six ureters. Two of the ureters emptied into the largest of the bladders, and the remaining four each into a separate bladder.

Malposition, or Hernia.—Displacement of the bladder may be both congenital and acquired,—generally the latter, when it is called *cystocele*.

The protrusion may occur at the linea alba in consequence of some weakness of the parietes in this situation, either from extreme distention of the walls by ascitic fluid, from a previous abdominal section, or from advanced age.

The bladder may also be displaced through one of the hernial passages, as the inguinal, the femoral, the obturator, or the ischiatic, either with or without a portion of the intestine or omentum. When occupying some of these unusual situations, it has been confounded with hernia, diseased testicle, and abscess.

Two cases are noted by Pott in which, in operations for strangulated hernia, the bladder was wounded. The same surgeon opened a scrotal swelling, which contained the bladder, under the supposition that he was dealing with a diseased testicle; and Verdier gives cases in which cystocele of the groin was mistaken for abscess. Vaginal cystocele is quite common in females who have borne children, the organ sometimes passing entirely out of the vulva. The bladder has been known to become prolapsed during parturition, and, being pressed upon by the head of the child, has been opened, under the supposition that it was a hydrocephalic head.

When the bladder is thus displaced it is without any peritoneal sac (a peculiarity first mentioned by Dominique Salla), unless where it has followed a large hernia, or where a very large portion of the organ is prolapsed.

The causes which are concerned in forming a cystocele are twofold: first, unusual dilatation of the bladder from frequent attacks of retention, followed by straining efforts to empty the viscus; and, second, a weakened condition

* *Cyclopædia of Anatomy and Physiology*, vol. i. p. 370.

† *Philosophical Transactions*, vol. vii.

of the parietes corresponding to those portions of the abdomen through which the great blood-vessels pass.

A cystocele must necessarily produce such an alteration in the form of the bladder that all the urine cannot be thoroughly expelled, and, as in the sacculated organ, a portion will remain, and cause, by its decomposition, those changes in the mucous membrane and in the secretion which are likely to result in the formation of stone, examples of which have been given by Rayseh, Paget, Petit, and others.

The diagnosis of cystocele, when not complicated with hernia, is not difficult to establish.

The tumor will be seen to increase with the accumulation of the urine, and to diminish during urination or catheterization. The sensation imparted to the fingers on pressure, palpation, or percussion is one of fluctuation, and not doughy, as in epiplocele, or elastic, resonant, or gurgling, as in enterocoele. In doubtful cases the grooved needle should be employed, and any fluid obtained subjected to such tests as will determine its character. When the viscus becomes strangulated, there are no signs corresponding to those of intestinal strangulation present. The vomiting, it is said by Petit, in hernia of the bladder is always preceded by hiccough, while in intestinal hernia this symptom follows the vomiting.

TREATMENT.—The treatment of cystocele consists in emptying the organ of urine, either voluntarily by the efforts of the patient, or by the catheter; during which pressure should be made on the swelling, when, if it has not formed adventitious adhesions, it may be restored to the pelvis, after which a truss must be worn, as in hernia, to prevent a second protrusion.

When the tumor proves to be irreducible, the indication will be to prevent its increase; and this will be most effectually secured by employing a truss with a concave pad, made to conform to the rotundity of the swelling.

When the prolapsus takes place into the vagina, passing, as it not unfrequently does, external to the vulva, little can be done except by an operation, and this is liable to fail. (See *Cystocele*.)

The various operations, which I have performed several times, will be described under the surgical diseases of females.

Inversion of the bladder, in which the organ becomes prolapsed to some extent through the urethra, can occur only in females whose urethræ are short and susceptible of very great dilatation. Examples of this form of extroversion are exceedingly rare.

Chopart, quoting from Percy, mentions the case of an abbess, fifty-two years of age, in whom the fundus of the bladder protruded through the urethra. It could be readily reduced with the finger, but immediately reappeared after removing the pressure.

Joubert records another case in most respects like that of Percy.

TREATMENT.—Extroversion may be treated by repeated cauterizations of the urethra with the hot iron, during which the bladder must be kept in place by a catheter. Dr. Lowe effected a cure in one case by this plan.

Incomplete inversion has been noticed in the male, but confined entirely to the mucous membrane of the bladder, and then not extending beyond the membranous portion of the urethra, as in the case narrated by Dr. Samberger.*

Exstrophy.—This is much the most uncommon of all the irregularities of vesical formation. It is met with in both sexes, but more frequently in the male. In twenty cases collected by Mr. John Wood, two were found in females. Mr. Earle, in sixty-eight instances of exstrophy, states that eight only were in females; and in fifty-three collected by myself from different sources, seven were in females.

This malformation consists in an absence, more or less complete, of the

* Diss. de Intussuscep. Membr. Urethræ, 1795.

anterior walls of the bladder, with generally a deficiency in the anterior parietes of the abdomen, and a corresponding absence of the pubic symphysis. The pubic bones, though generally separated some distance from each other, and having a band of fibrous tissue bridging over the space between the two, yet are in some cases in contact. The posterior wall and fundus of the bladder protrude forward, its mucous membrane forming a red, spongy-looking surface covered with vesical mucus, on which may be discovered the openings of the ureters, which are sometimes considerably dilated. The size of the extroversion varies, according to the age of the patient and the degree of abnormal pubic deficiency, from that of a walnut to half the palm of the hand.

The margin of the opening in the anterior parietes through which the posterior wall of the organ projects, is generally irregularly oval. In typical cases the umbilicus is wanting. The penis also participates in the vice of conformation. It is stunted, turned backward, flat, and has a gutter on its upper surface, which is the lower semi-circumference of the urethra. At the vesical extremity of the latter may be seen a dwarfed prostate, prostatic sinuses, and the intermediate veru montanum, with the little slits marking the terminations of the ejaculatory ducts. This defect constitutes a complete epispadias of the organ. In some instances the cavernous bodies are separated from each other for a considerable extent posteriorly. The scrotum, though generally present, may be altogether absent.

There is usually present in these cases of marked exstrophy double inguinal hernia, the intestines passing down into the scrotum, the division of which, by the intermediate notch or depression resulting from the extent of the interpubic space, gives to its halves the appearance of the labia majora of the female.

In the absence of the scrotum the testes are generally situated in what would correspond to the inguinal canal, and are normal in size and structure.

The mucous membrane which protrudes, being exposed to the friction of the clothing, to the action of the air, and to a highly-alkalinized and decomposing urine, is constantly in a chronically-inflamed state, while the thighs, the lower part of the abdomen, and the perineum and nates, together with the clothing, are constantly wet with ammoniacal urine, altogether rendering the subject of this horrid malformation an object of sincere commiseration.

There are other cases of extroversion of a much less pronounced character, in which the genital organs are not involved, where the pubic bones, though not firmly united by intermediate cartilage, are in near juxtaposition, and bound to each other by interlacing bands of fibrous tissue, the vicious conformation being limited to the space between the hypogastric portion of the recti muscles and not reaching to the umbilicus, the latter being present and properly formed.

This peculiar malformation has been studied by embryologists, and is shown to be an arrest in the anterior development of the lateral portions of the allantois, the blending of which in the median line is necessary to the completion of the anterior lateral walls of the bladder. This vice in development does not destroy the venereal appetite, though such persons are necessarily unable to effect successfully the sexual act.

In exstrophy of the bladder in the female there is the same defect in the symphysis pubis, though not to the same degree, as in the male. The cleft extends backward, separating the labia majora and labia minora, and the vagina appears as an elongated, transverse fissure, being also more shallow than normal. The deformity causes less sexual disability in the female than in the male, and, as the uterus and ovaries are not necessarily involved in the defect, it is not incompatible with sexual intercourse and conception of which there are cases recorded—one by Dr. Huxham and a second by Thiebault—in which parturition occurred. Todd refers to one of the anatomical abnormalities which sometimes accompany exstrophy, related by Bartholin.

in which, in addition to the defect in the anterior wall of the bladder, the penis and anus were both absent, all the ingesta taken by the individual returning by the mouth for forty years. The deformity of exstrophy, though a horrid and disgusting one, is not inconsistent with long life. Flajani speaks of one case living at seventy, and Quatrefages of others of forty-nine. A man well known to the medical students of Philadelphia, who appears annually before the classes, and whose exstrophy constitutes his whole capital in trade, is forty years old.

TREATMENT.—Whether the treatment is mechanical or operative, the object must be the same, namely, palliative.

The mechanical appliances which have been devised with a view to collect the urine have all signally failed to accomplish the object. The best apparatus of the kind is that designed by Mr. Earle, one of the surgeons of St. Bartholomew's Hospital, London, which consists of a concave cup of metal, with a rounded border, designed to make a harmless depression in the integument surrounding the extroversion, but not to touch the mucous membrane at any point, and secured in place by a strap buckled round the pelvis like a truss. At the lower part of this shield is a tube connecting with a gum bottle, which is fastened to the thigh, and into which the urine is directed. (Fig. 1352.)

Various ingenious operations have been originated for the relief of extroversion of the bladder, some of which have been quite successful. The experiment of establishing a communication between the ureters and the rectum has been tried by Mr. Simon and Mr. Sidney Jones, of St. Thomas's Hospital, London, by introducing setons of thread between the two. Instead of attempting to create a fistulous opening between the ureters and the rectum, others, as Mr. Lloyd and Mr. Johnson, have endeavored to accomplish the same object by passing a stout seton of silk through the wall of the bladder and intermediate tissues into the rectum.

These operations have not only failed to turn the urine into the bowel, but in the cases operated on by the last two surgeons named were followed by fatal peritonitis.

Mr. Holmes has suggested a method of opening a communication between the bladder and the rectum by instrumental compression of the *trigone vesical*, between the ureters, until the tissues are destroyed by ulceration and sloughing. These procedures are all attended with considerable danger to life. If even the urine could all be successfully diverted into the bowel it is doubtful whether this would be the most satisfactory disposition that could be made of it. This opinion is based on the study of a patient who has been several times under my care, having a recto-vesical fistula, which allows a considerable portion of the urine to enter the rectum, where it is a source of great discomfort, although it can be retained for two or three hours at a time.

Dr. R. J. Levis, in a lad fourteen years of age, who was admitted into the Pennsylvania Hospital suffering from exstrophy of the bladder, attempted to relieve the deformity by first establishing a fistulous opening between the bladder and the perineum, which was done by introducing through both first a stout silk thread, and afterwards a soft, flexible bougie. A second operation was done some time after, with a view to cover in the anterior opening of the bladder by reflecting the integument from the scrotum and sliding it, with the cutaneous surface turned inward, beneath the integument at the circumference of the opening, which had been dissected up for

FIG. 1352.



Urinal applied for exstrophy of bladder.

the purpose, and uniting the two by numerous sutures. The penis was also turned into the bladder. The urine was conducted from the bladder by a catheter introduced through the opening in the perineum. The patient died twelve days after the operation, from exhaustion produced by obstinate vomiting.

CLOSURE BY FLAPS.—This plan of supplying an anterior wall to the bladder has been practiced at different times, and in some of its modifications promises results of a more practical character than any other operation which has as yet been devised.

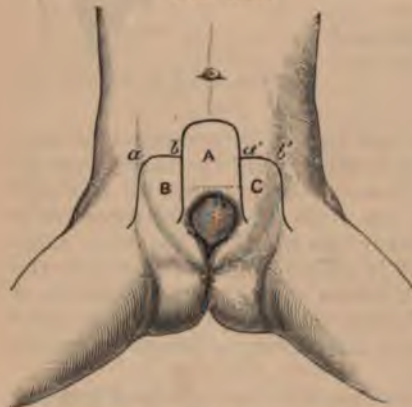
Among the first efforts for the relief of exstrophy by this method were those of Roux and of Richards, in 1853, in which two flaps were raised,—the one from the scrotum, and the other from the abdominal parietes above the opening. The disposition of these two flaps was not alike in the two operations. In that of Roux, the scrotal flap was turned with its cutaneous surface inward, and attached above to the abdominal flap. In that of Richards, the abdominal flap was turned down with the skin inward, and its raw surface covered with scrotal flaps.

Professor Joseph Pancoast, of Philadelphia, and Dr. Daniel Ayres, of Brooklyn, New York, in 1853, each succeeded in closing in a case of exstrophy. In Dr. Pancoast's case, two flaps were raised, one from each inguinal region, and brought together in the median line, where they were secured by sutures, the cutaneous surfaces being inward, in which position the raw surfaces gradually cicatrized. In Dr. Ayres's case, one flap was obtained from the umbilical region and turned down over the opening, its raw surface being external; to cover this, two additional tegumentary flaps were dissected from the sides of the abdominal walls contiguous to the exstrophy, and drawn together over the first. By this method no raw surface was left exposed.

These were the first successful plastic operations for the relief of vesical exstrophy.

Mr. Bryant, of London, has had successful cases of operation for exstrophy, the flaps being taken from the groin and from the scrotum, the latter being used to cover the raw surface of the former. Professor Wood, of King's Col-

FIG. 1353.



Lines of incision in Wood's method (from Ashhurst).

FIG. 1354.



Operation of Maury for exstrophy of bladder—

lege, London, who has operated seventeen times for the relief of this malformation, combines the methods practiced by Pancoast and by Ayres,—that is, a lid of integument is turned down from the abdomen above the opening with its skin surface inward, and this flap is covered by two others taken from the inguinal regions. (Fig. 1353.) Professor Ashhurst has repeated this operation in three cases, two of which were successful.

Dr. Maury, in two instances, dissected a large convex flap of integument from the groin, perineum, and scrotum, and, after cutting a small slit, through which was slipped the penis, turned the flap upward, skin surface down, over the exstrophy. A short flap of integument was next raised from the upper and lateral portions of the opening, beneath which was slid the margin of the first flap, the two being connected by stitches similar to the tongue-and-groove suture of Professor Pancoast. This plan is a modification of that of Roux. (Fig. 1354.) This procedure I practiced with a most satisfactory result in a child operated on before the medical class at the University Hospital, the cicatricial tissue by its contraction at the same time curing a double inguinal hernia which existed, a result which also followed in both of Maury's cases. Professor Bigelow, of Boston, diminishes the extent of the mucous surface by denuding the posterior wall of the bladder of its lining membrane on a line with the ureters, using two flaps, one from each inguinal region, to cover in the raw surface and the exstrophy below.

No single plan of operation will meet the requirements of every case. The procedure of Ayres has the widest application, suited as it is alike to the male and to the female; though when the case is a male the operation as modified by Maury will often promise the most satisfactory result. After the adjustment of the flaps, the patient should be placed in a position which will cause as little tension as possible on the sutures,—that in which the trunk and thighs are well flexed. A water dressing, or a dressing of carbolated oil, will be best suited for covering the wound. The evils most to be apprehended are erysipelas and sloughing of the flaps.

Of the value of these operations to patients suffering from exstrophy there can be no doubt. Although control over the urine is not secured, the flow is limited to a single point, rendering the adjustment of a urinal practicable, and thereby protecting the abdomen and limbs from contact with the water.

The results furnished by these operations for exstrophy are quite encouraging. Of 55 cases analyzed by Dr. Ashhurst, 43 recovered, 4 failed, and 8 died,—a death-rate of only 14.6.

The Urine.

The diseases which arise from functional and other disturbances of the kidneys demand a very careful study of the urine, in both its normal and its abnormal states. The urine is a very changeable secretion, and is much influenced by disease, injury, emotional causes, food, drink, exercise, and repose.

Normal urine is of a light or yellow color, has a specific gravity of about 1020, emits an unpleasant odor peculiar to the secretion, and yields a faintly acid reaction. The average quantity passed by an adult during twenty-four hours is about forty-five or fifty ounces. Considerable deviations from the above characteristics may exist without being incompatible with the normality of the secretion. Thus, a free use of water or other drinks, the action of diuretics, or a slight excitement of the nervous system will not only render the urine much lighter in color, but will also cause a marked increase in quantity with a lower specific gravity; or it may be diminished in its transparency by the accidental presence of an excess of mucus and epithelia, both derived from the genito-urinary tract. The same effect will be produced by the formation of an undue amount of the earthy phosphates or urates in the secretion. The reciprocal action of the skin and kidneys, so well understood by physiologists, materially affects both the color and the quantity of the urine. Thus, during the heat of summer, when the sensible perspiration from the glandular apparatus of the skin is increased, thereby diminishing the watery constituent of the secretion, the urine is darker in color and less in amount than in winter. Certain substances when taken into the

stomach and subjected to digestion impart a peculiar color to the water: thus, the internal use of santonin renders the urine yellow.

The odor of urine is also modified by the internal use of certain medicinal substances, as the turpentine, cubebs, and copaiba; or by different articles of food, as asparagus, onions, etc.

REACTION.—The acid reaction, which for the whole quantity of the twenty-four hours' urine is quite constant, may be temporarily changed by the process of digestion, becoming after a full meal alkaline or neutral, either in consequence of the amount of alkaline principles contained in the food, or, as others suppose, from the extraordinary demands made on the blood by the gastric juice at this time, by which the acids of the body are for a time diverted from the renal secretion.

COMPOSITION.—The urine consists of various organic and inorganic substances dissolved in water. The latter amounts to about nine-tenths of the whole, or 933 parts in 1000.

The organic matters are derived from the destructive or retrogressive metamorphosis of the tissues of the body, and from the food during its preparation and assimilation. The most important of these substances to the surgeon are urea and uric acid. The less important consist of creatine, creatinine, and lactic and hippuric acids, the last two being formed from the food during its assimilation. The inorganic constituents of urine are both saline and mineral. They exist as phosphates, sulphates, and chlorides, formed by the union of their respective acids with bases of potash and soda. The bases of the mineral salts are, for the most part, lime and magnesia. In addition to the above ingredients there are others which are derived from the urinary passages, as mucus-corpuscles, and renal and vesical epithelium.

PATHOLOGICAL CHANGES.—When there is present in the urine an abnormal amount of urates, as soda, lime, potash, and magnesia, though they may not appear at the time the secretion is voided, they will be precipitated as the temperature of the urine is lowered, rendering it thick, muddy, and turbid, and leaving a pink deposit or crust adherent to the containing vessel. The nature of this deposit can readily be determined by the addition of heat, on the application of which the urates are quickly redissolved and held in suspension by the watery part of the urine. This state of the urine is often witnessed in persons suffering from indigestion and fever, or from rheumatic and gouty attacks.

In other instances the deposit may be made up of phosphates of lime and magnesia. These finally settle to the bottom of the vessel, forming a heavy and cloudy deposit, and may readily be confounded with a deposition of mixed urates. The distinction, however, can be established without difficulty by either the application of heat or the addition of a little nitric acid to the urine. The sediment, if it consists of phosphates, will quickly clear up on the addition of the acid, but will be increased by heat.

The urine may also be rendered opaque by the presence of pus, by an undue amount of mucus, or by both. When pus alone exists in the secretion, it subsides quickly to the bottom of the vessel, leaving the supernatant liquid clear; but if mingled with mucus, buoyed up by the latter it will float for a long time in the urine before settling as a deposit, thus rendering the water cloudy or opaque for a considerable period. By the addition of heat, however, this cloudiness may readily be distinguished from the turbidity resulting from a redundancy of urates, for instead of clearing up, as in the latter condition, the opacity will become more dense from coagulation of the albumen contained in the pus liquor.

In chronic cystitis muco-pus constitutes the leading characteristic of the urine. Not only so, but it imparts to the latter a viscid, ropy consistence, resembling a thick decoction of flaxseed-tea.

The density of the urine has been stated to be about 1020, but is subject to great variations. When containing much albumen, as in Bright's disease of the kidneys, the specific gravity is diminished, except in the acute stage,

when the presence of blood tends to make it higher. In diabetes mellitus the density is signally increased, reaching in some cases as high as 1040 or 1050. In the early stage of all acute fevers the specific gravity is also increased, and the same is true when there is an unusual activity of the cutaneous glands, as in sweating or after violent exercise. In all these conditions the increased density is to be attributed to destructive metamorphosis of the tissues increasing the amount of urea in the secretion. The specific gravity of urine is determined by the *urinometer* (Fig. 1355), an instrument which, though not absolutely correct in its registration, is sufficiently accurate for all practical purposes.

In using this little instrument, the urine should be placed in a tall, narrow, glass vessel, and the urinometer floated in the liquid. (Fig. 1356.) The depth to which it sinks will be indicated by the figures on the scale, and the specific gravity may be ascertained by adding this number to 1000, which stands for unity. As the urinometer has been graduated at 60° Fahr., the urine should have the same temperature to make the instrumental examination accurate.

In ascertaining the specific gravity of urine, we also obtain *approximately* the amount of solid matters which the secretion contains by multiplying the number above 1000 by 2 for densities under 1018, and for all above 1018 by 2.33. For example, in a specimen of urine the specific gravity of which was 1015, there would be 30 grains of solid material in the 1000 grains of urine. If the specific gravity of another specimen amounted to 1.020, there would be in the 1000 grains 46.66 grains of solid matter.

Quantity of urine.—As already stated, the average amount of urine passed twenty-four hours has been fixed at forty-five or fifty ounces in health; but great fluctuations from the normal standard are observed in disease. The most remarkable example of an increased quantity is witnessed in diabetes mellitus, when several gallons may be discharged in the twenty-four hours. In hysterical and other convulsive affections, also, the amount excreted is far above the average.

Whatever tends to obstruct the portal venous circulation, as disease of the heart or of the liver, will, by increasing the blood-pressure in the kidneys, contribute to an increase in the amount of the urine. In shock, in diarrhoea, exhaustion, in the sweating of hectic, in Bright's disease, particularly in its advanced stage, in dropsy, in contracted and in albuminoid kidney, and in all acute forms of fever, the urinary secretion is diminished in quantity.

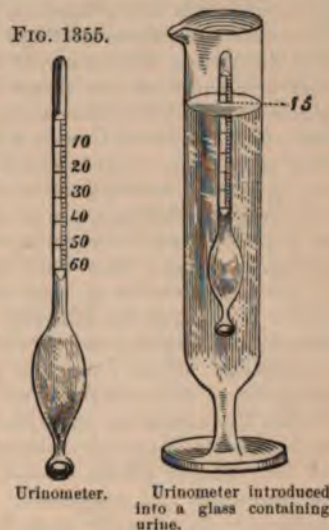
Frequency of urination is a very constant attendant of all diseases affecting the bladder or the kidneys, though there is not in such cases necessarily any increase in the amount voided during the twenty-four hours.

Odor.—The usual urinous or so-called aromatic odor of urine is frequently changed from pathological causes. When the urine is saccharine, it often emits a sweetish odor; when it deposits the unusual sediment of cystine, it may have the smell of sulphuretted hydrogen; and in most cases of cystitis arising from spinal injury, paralysis, stone, or prostatic disease, there is very commonly both an ammoniacal and a putrid odor,—the result in the first case of the ammonia liberated in the decomposition of urea, and in the last of the decomposition of the abundant mucus derived from the mucous membrane of the bladder.

Reaction.—Healthy urine being usually acid, it will redden blue litmus-

FIG. 1356.

FIG. 1355.



Urinometer.

Urinometer introduced into a glass containing urine.

paper. The acidity of the secretion is probably due to the combined effects of several of its acid constituents, as uric, lactic, and hippuric acids, and chiefly the acid phosphate of soda. The fluctuations in the reaction of urine from the effects of food and digestion have been already noticed. The acidity of urine is increased by both mineral and vegetable acids, as the nitric, sulphuric, tartaric, etc., etc. A similar increase will be found to exist when the function of the cutaneous glands have been lessened or suppressed, inasmuch as an additional amount of acid substances, as butyric, formic, propionic, and sudorific acids, and urea, which should normally escape by the perspiration, is compelled to find its way out of the system through the renal organs, which in great measure are obliged to provide for the failure of the skin to do its duty. Whatever interferes with the digestion of the food, producing sour eructation and flatulence, will intensify the acidity of the urinary secretion, as will any interference with the proper disposition of the products of tissue-change; hence the acidity of the urine in rheumatic and gouty diseases. Urine which has stood for some time in a vessel, though acid at the time of being voided will after a short time become alkaline. An elevated temperature conducive to, or rather hastens, such change, the result being brought about by the mucus and other organic substances playing in their decomposition the part of a ferment, and converting the urea into carbonate of ammonia, a change which may take place both in and out of the bladder.

The introduction of blue litmus-paper into a specimen of urine will, if the latter is alkaline, be followed by no change in the color of the paper. The cloudy state of the urine which is frequently witnessed when the secretion is alkaline arises from the precipitation of the earthy phosphates by the presence of either a fixed or a volatile alkali, or of both at the same time. When the deposit is amorphous, it has been determined by the fixed alkali and consists of the phosphate of lime; when crystalline in character, it is due to the volatile alkali, as the carbonate of ammonia forming the phosphate of ammonia and magnesia. In such urine a greasy or iridescent scum or pellicle is occasionally seen floating on its surface.

The morbid conditions which are actively concerned in imparting alkalinity to the renal secretion are dyspepsia, injuries of the spine, paralysis, etc.

Albumen.—Among the organic constituents of urine albumen is frequently found, and its presence is always very significant, awakening usually the anxiety of the physician, and leading him to a careful examination of the organs of the body. Albumen appears in the urine abundantly in Bright's disease of the kidneys; during the latter months of gestation in the female; in dropsical affections; in pneumonia; sometimes in traumatic and other fevers, and also during the course of other diseases.

The recognition of albumen is accomplished by the tests of heat and nitric acid.

The heat test is made in the following manner. Fill an ordinary glass test-tube about one-third full of urine, and apply heat from a gas-jet or by means of a spirit-lamp. If the contents of the tube become cloudy, or somewhat opaque, it will be due to the presence of a deposit either of earthy phosphates or of albumen, which may be quickly determined by the addition of a few drops of nitric acid, when, if the opacity is due to phosphates, it will rapidly disappear, and if caused by albumen it will be increased. Should the urine at the time of its being subjected to this test prove to be alkaline, the addition of a few drops of acetic acid, and then boiling the fluid, will be a proper preliminary measure to the experiment. Urates and albumen may exist in the same specimen of urine. When the heat is applied, the amorphous urates will be quickly redissolved, after which the albumen will be deposited.

Nitric acid constitutes a very delicate test for albumen. The method of Heller is the one best adapted for this purpose. By this plan a small quantity of nitric acid is introduced into a glass test-tube, and when the latter is inclined to one side, the same amount of clear urine is allowed to trickle down the side of the tube, a drop at a time, discharged from a pipette. As the tube

liquids come in contact, in the urine on top of the acid there will appear, if albumen is present, a white stratum or zone. As a white cloud may form, when there exists an excess of mixed urates in the urine, on the application of this same test, it is proper that the true nature of this deposit be recognized. This knowledge is most satisfactorily obtained by adding heat to the urine in which the white band appears, when, if dependent on amorphous urates, it will quickly clear up; if on albumen, the reverse will be the case. Urine containing albumen has a low specific gravity.

Pus is frequently found in urine, and may be derived from any portion of the genito-urinary tract. When the quantity is considerable, it settles to the bottom of the liquid, forming a white, opaque, or yellowish sediment. In the event of much mucus existing in the water along with the pus, the latter remains for a long time suspended by the former. It is possible, on a simple inspection of urine, to confound the deposit of pus or muco-pus with urates. Any mistake of this kind may be corrected by applying heat, which will redissolve the deposit, if consisting of urates, and restore the urine to its original clearness; but if the sediment is formed of pus, the albumen of the liquor puris will be deposited, and thereby increase the cloudiness of the liquid.

Amorphous phosphate of lime also bears some faint resemblance to pus, but nitric acid will clear up any opacity from this substance, while it will increase that arising from pus by precipitating its albumen.

The diagnosis of purulent urine has been based upon its behavior with alkalies, as the liquor potassæ, which, when added to the deposit of pus, after the urine has been poured off, will form with it a tenacious, viscid, or gelatiniform substance, which pertinaciously adheres to the bottom of the vessel, even when the latter is inverted. This is *Donné's test*. The microscope furnishes the most satisfactory evidence of the presence of pus. (Fig. 1357.)

Pus in the urine is generally an indication of some serious trouble in the kidney, the bladder, the prostatic body, or the urethra. It is not always an easy matter to designate the exact source of the fluid. When derived from the kidney, the ordinary acid reaction of the urine will remain unchanged, in consequence of the absence of mucus, which is so actively concerned in the production of fermentation; but when formed in the bladder it is soon associated with an alkaline state of the urine.

The acid reaction of the urine will be retained also when the pus originates in the urethra and prostate body, provided cystitis does not exist.

When derived from the prostate, the pus-cells not unfrequently are arranged and connected with one another in a linear or thread-like form, and may be seen floating in the urine. Pus is always found in the renal secretion in cases of nephritic calculus, nephritis, cystitis, prostatitis, and urethritis. Pus may be altogether accidental to the urinary secretion, being derived from the vagina or the ureters in the female, or from a perineal or urethral fistula.

Blood may enter the urine from the same sources as pus. The appearance presented will depend on the amount of the fluid contained in the secretion. It imparts to the urine a reddish or a brown, smoky hue, quite characteristic. The microscope will always resolve any doubt entertained by the surgeon, by revealing the blood-corpuscle, when it exists in the urine. The color, it is

FIG. 1357.



Corpuscles of pus: those at the lower part of cut, acted on by acetic acid.

proper to say, is influenced by the reaction of the urine, being red in alkaline and dark in acid urine.

In order to trace the blood to its proper source, attention must be given to the form of the accumulation. When in clots, it probably has an origin not higher than the bladder; when equally diffused through all parts of the water, its renal origin will be highly probable; and when discharged in the form of small cylinders, the posterior portion of the urethra most likely supplies the blood, which becomes moulded to the shape of the canal as it slowly escapes from the vessels.

Epithelium.—There are three forms of epithelium met with in the urine,—the round, the squamous, and the cylindrical. (Fig. 1358.)

The round and the cylindrical, or columnar cells, exist in all parts of the genito-urinary tract, from the infundibula of the kidney to the urinary meatus. The squamous are confined chiefly to the mucous membrane of the bladder. In all inflammatory diseases of the mucous lining of the urethra, bladder, ureters, and kidneys, the attendant desquamation furnishes an abnormal amount of epithelium to the urine, though, unless associated with other symptoms, it is impossible to recognize the exact part of the extended mucous membrane from which they have been detached. These cells can be distinguished from the pus-corpuscles by the single nucleus which they contain,

FIG. 1358.



a, round epithelium from bladder.
b, columnar epithelium from ureter and urethra.
c¹, columnar and squamous epithelium from deeper epithelial layers of bladder.
c², squamous epithelium from superior layer of epithelium of vagina.

whereas the pus-cell has several, and requires for their exposure the addition of a little acetic acid.

Tube-casts are formed by a fibrinous transudation or extravasation into the uriniferous tubes from the contiguous vessels. This transudation, coagulating and incorporating with it epithelial cells, blood, etc., assumes the form of the tubule in which it lies; and when expelled into the ureter it passes into the bladder as a cylindrical cast. These plugs are distinguished as epithelial, granular, fatty, and blood casts.

The *epithelial cast* (Fig. 1359) consists of renal epithelia, either imbedded in a fibrous transudation or simply aggregated together and assuming the form of the uriniferous tubule.

The *granular cast* (Fig. 1360) is made up of the particles resulting from a disintegration of epithelial cells or blood-corpuscles.

Fatty casts (Fig. 1361) are those which contain chiefly oil, both in the epithelium and in a free state.

Blood-casts may contain little else than blood-corpuscles united together by fibrogenous substances.

Hyaline casts present different appearances according to their composition. When made up of fibrin without epithelial cells, they exhibit a homogeneous and transparent appearance; when containing a few oil-drops, they present here and there yellowish points; and when more consistent, and having the appearance of melted wax (Fig. 1362), they constitute the variety termed waxy casts.

The significance of these tube-casts is quite important, indicating serious disease of the kidney, and often contra-indicating surgical operations. The

FIG. 1359.



Tube-casts in acute desquamative nephritis—
Bright's disease.

FIG. 1360.



Granular tube-cast.

fatty and hyaline casts are found in their most typical forms in Bright's disease of the kidney. The waxy hyaline casts, though seen to some extent in both acute and chronic Bright's disease, greatly exceed all others in the

FIG. 1361.



Fatty cast.

FIG. 1362.



Hyaline waxy cast, with epithelial cells from the
bladder.

wax kidney, a disease which generally is much less rapid in its progress than that known as Bright's. Granular casts belong more especially to the granular or contracted kidney, and are not present in the early or acute stages of the renal diseases.

Spermatozoa are frequently found in the urine. These cells possess an elongated head attached to a long filament. (Fig. 1363.) They enter the urethra along with the semen, and are washed out during urination. They may even reach the bladder and mingle with the urine before it has been passed from that viscus. When present in large numbers, together with spermatic fluid, they impart a slightly cloudy appearance to the urine.

They are easily detected by the microscope with a power of 400 diameters. Their presence generally indicates a capacity for fruitful intercourse when not associated with sexual impotence.

These bodies may be detected in the stains on the linen of masturbators by soaking it in a little water for a short time and afterwards examining the solution microscopically.



Sugar in the urine is another symptom of the gravest import. The high specific gravity alone of the secretion (1030) will be sufficient to awaken a suspicion of its existence. If to this is added a very large increase in the quantity of the water, with urgent thirst, its presence will be still more probable.

Saccharine urine, however, may be positively demonstrated through the agency of certain tests, of which there are a great number. Five may be mentioned,—namely, the copper or Trommer's test, the bismuth or Boettger's test, the fermentation test, the Moore test, and the Heller test.

Copper test.—To the specimen of urine to be examined add a few drops of a solution of sulphate of copper (one part of the sulphate to thirty parts of water), and afterwards liquor potassæ in excess, or an amount equal to half the volume of urine under inspection. The effect of adding the liquor potassæ is to liberate a hydrated protoxide of copper, and by continuing to add the alkali, if sugar is present, the precipitate will be redissolved, leaving a blue, transparent fluid. That the test may be more conclusive, let the mixture in the glass tube be boiled, when, in the event of the urine being saccharine, an abundant yellow precipitate will be deposited, consisting of the hydrated suboxide of copper, which after a time becomes, by the loss of its water, the red suboxide of copper. To give additional certainty to this copper test, a second mixture, prepared as described, should be set aside, without boiling, for several hours, when, if sugar is present, a similar precipitate of the red suboxide will follow. The experiments of Dr. George Hay, of Alleghany, Pennsylvania, in common with those of other writers, have shown that, under certain conditions, the copper test cannot always be relied on, as when there are present in the urine certain compounds of ammonia, as the chloride and the urate, which defeat the reduction of the oxide of copper and thus render the examination unreliable. Another precaution must be observed in testing the urine for sugar,—namely, to get rid of any albumen which may exist in the secretion.

Bismuth test.—Add to the urine to be examined an equal amount of liquor potassæ, then a small quantity of subnitrate of bismuth. Shake the mixture, then boil it for two or three minutes. If sugar is present, there will be deposited on the sides of the test-glass a black powder (metallic bismuth), produced by the property possessed by sugar of reducing the salts of bismuth to the metallic state. The caution to be employed in this test is not to use any excess of bismuth, a few grains being sufficient.

Fermentation test.—This is the most troublesome, but also the most reliable, of all tests for sugar. Into a large-sized test-tube provided with a cork stopper, through which is passed one branch of a bent glass tube reaching to the bottom, introduce one drachm of brewer's yeast, and fill up the tube with urine. Then, introducing the stopper, place the apparatus in a vessel containing lukewarm water, and set it aside in a room in which the temperature is about 70° Fahr. If the liquid contains sugar, in the course of twelve hours fermentation will commence, and the disengagement of carbonic acid gas will force the liquid out through the bent tube. Saccharine urine is frequently noticed in cases of gangrene of the feet.

Moore's test.—Placing a small quantity of urine in a test-tube, add to the same about half the quantity of liquor potassæ, and boil. If there is any sugar present in the liquid the latter soon becomes of a yellowish-brown color, which deepens in tint as the boiling progresses, becoming finally almost black when the urine is rich in sugar. This test is based on the fact that, grape

sugar and diabetic sugar being identical, the saccharine matter undergoes oxidation when boiled with caustic alkali, the oxygen being derived from the air. The dark coloration is produced by the glucic and melassic acids.

Heller's test, which is a modification of the above, consists in adding a few drops of nitric acid to the colored fluid produced in Moore's test, the effect of which is to destroy the dark coloration, at the same time developing the odor of burnt molasses.

In all the tests where solutions of potash or soda are employed, the liquids should be kept in green glass bottles, as when preserved in flint-glass bottles they are liable to become impregnated with lead, the action of which, when boiled with organic matter containing sulphur, is to produce a brown color from the formation of sulphuret of lead.

Bile in the urine may be suspected when the secretion has a yellow color, or when it imparts a yellow stain to a piece of linen moistened in the fluid. To render the recognition certain, the tests of Gmelin should be employed. The first is the *nitrous acid test*, and the simplest manner of using it is to place a few drops of urine on a porcelain plate, and close alongside a like quantity of fuming nitric acid. The gradual intermingling of the two liquids is followed, if bile is present, by a play of colors,—green, blue, violet, red, and yellow.

Whenever any important operation is contemplated, it is a very wise precaution to subject the urine to a careful preliminary examination, and if it is found to contain albumen, casts, sugar, or bile, the utmost care should be exercised in the management of the case.

Urinary Deposits.

Normal urine, when fresh, furnishes no deposits except a little mucus, with a few epithelial cells, which, as the liquid cools, subsides. Yet even normal urine, when exposed to the air, will undergo, in the process of fermentation, such changes as give rise to deposits of different kinds.

Among these may be noted amorphous granular substances composed of acid urates, such as potash, soda, and ammonia, all of which are soluble by means of heat. The most common organic constituents of the urine concerned in determining depositions are uric acid and urea.

URIC ACID is an extremely insoluble substance, one part of the acid requiring 1800 parts of hot water to dissolve it. It constitutes a very small proportion of the urine,—about one grain in 1000 grains of urine. The uric acid deposits may appear as a lateritious sediment of yellowish or red sand or gravel, consisting of variously-shaped crystals not inaptly compared to particles of cayenne pepper, which adhere as a crust to the vessel in which the urine has been allowed to stand. The presence of uric acid is associated with a very decided acidity in the reaction of the urine. It is the most common constituent of vesical calculi: hence its synonym *lithic acid*.

The crystals of uric acid have various forms, as rods, squares, plates, compact bundles of needles, though the prevailing forms are lozenge- or rhomb-shaped (Fig. 1364), and are of a pale straw-yellow or orange-red color. They constitute, in combination with potash, soda, magnesia, lime, and ammonia, the deposits known as *urates*.

Tests.—Both uric acid and the urates may be discriminated by the appearances which follow the addition of a drop or two of nitric acid to a deposit containing these substances, placed on a porcelain plate, and then evaporated over the flame of a spirit-lamp. A drop or two of liquor ammoniæ added to the residue brings out a beautiful purple hue. This appearance is believed to result from the formation of alloxan, allantoin, and ammonia.

To distinguish between uric acid and the urates, however, requires the use of the microscope.

URATES.—The urates constitute the great bulk of all urinary deposits, the most common being the urate of ammonia and the urate of soda. They

appear as an amorphous sediment (Fig. 1365) having a variety of colors,—pale red, pink, yellow, etc.

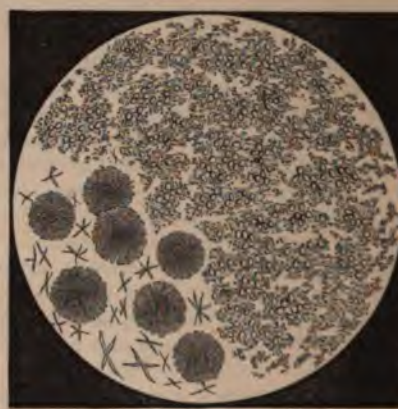
The urine from which these deposits are precipitated has a specific gravity

FIG. 1364.



Uric acid crystals.

FIG. 1365.



Amorphous urates.

either slightly under or slightly over the normal standard, in color resembles pale sherry wine, has a strongly acid reaction, is not materially increased in quantity, and when voided is quite clear.

CAUSES.—The uric acid deposits result from a rapid waste of the tissues, such as accompany a high grade of inflammatory or acute disease.

In gout and rheumatism they appear particularly when the climax has been attained and these diseases begin to decline. Their presence at this juncture has procured for them the reputation of being *critical*.

Defects in the process of digestion, either in the preparation of ingesta in the stomach and small intestine, or in the work of assimilation, and an excess of nitrogenized food, together with inactivity of the cutaneous excretions, are fruitful sources of the accumulation of uric acid in the blood. The brick-dust and fawn-colored deposits are believed by some to arise from this cause. Hence these deposits are often witnessed in the urine of sedentary or indolent persons who suffer from dyspeptic symptoms and who eat freely of animal food.

The consumption of oxygen and carbon which occurs in respiration is not without an important influence, independent of blood-aeration, in preventing the deposits under consideration, by using up the materials which otherwise would go, in combination with urea, to form objectionable products. Whatever, then, tends to lower or embarrass the respiratory function will, it is believed by those who have carefully studied this subject, increase the uric acid of the urine.

Disturbance of the functions of the liver, which consumes a large amount of carbon in the disposition of the fatty substances of the food, may also conduce to the same result much in the same way. It is to this cause that Dr. Golding Bird ascribes the presence in the urine of the pink, crimson, and purple deposits. In all liver affections there is usually a deposition of uric acid with amorphous urates. Especially is this noteworthy in malignant diseases of the organ, in which, as compared with those of a benign or non-malignant nature, particularly in their latter stages, the uric acid is in great excess,—a fact which is not without its value from a diagnostic point of view. The kidneys also, when their eliminative function has been disturbed by disease or injury, contribute largely to the production of the same deposits.

In fine, everything which tends to interfere with the proper arterialization

of the blood tends also to increase uric acid, by diminishing the urea, through the combination of the latter with oxygen and carbon.

TREATMENT.—In the treatment of the uric acid diathesis the true cause of the disease must be carefully sought. The great indications are, to regulate the diet so as to exclude all nitrogenized articles of food, and so as to aid stomachic and intestinal digestion, thus securing as much as possible the consumption of those materials which, if allowed to accumulate in the blood, tend to ally themselves with urea.

These indications will be fulfilled by regulating the food both as to quality and as to quantity. Whatever has been found in the experience of the patient to cause acid eructations and flatulence must be interdicted. Animal food of all kinds is to be used sparingly, and should always be prepared either by roasting or by broiling. Fats, oily dressings, hot cakes, fresh bread, pastry, butter, sugar, sweet potatoes, and onions must be avoided. Instead thereof the patient may be allowed stale bread, soda biscuit, rice, milk, eggs, tea, ripe fruits, celery, tomatoes, and white potatoes. Alcoholic drinks must be forbidden; but, if stimulus has been rendered necessary by previous habits, a little whisky may be allowed at dinner.

The second indication will require for its fulfillment the restoration as far as possible of the proper functional activity of all the organs of the body which are prominently concerned in the work of secretion and excretion. The bowels are to be kept in a regular state, which will be best secured by the occasional use of a little blue mass at bedtime, and in the morning following, three-quarters of an hour before breakfast, of two or three drachms of the sulphate of soda largely diluted with water.

Daily exercise in the open air on horseback, or, what is better, on foot if the strength will allow, is of the first importance. An active out-door life improves the respiration, increases the action of the skin and kidneys, and secures the oxidation of those products which result from the retrograde metamorphoses of the tissues. The large amount of solid matters which find their way out of the system through the glandular apparatus of the skin renders it desirable to keep this emunctory in the best possible condition for executing the task of elimination, which will be materially promoted by tepid bathing and frictions, and by proper care in clothing. Attention to the above instructions cannot fail to exert a great influence in correcting this disease.

The medicinal treatment should be directed to the removal of hyperacidity and the improvement of the general health, for which objects a combination of alkalies and tonics is required.

Among the best agents of this kind is the compound infusion of gentian, with the bicarbonate of soda or potash, and the tincture of nux vomica. If alkaline remedies are contra-indicated, those acid salts which, in passing through the system, are converted into alkaline carbonates, may be substituted, as the citrates, acetates, or tartrates. Iron and quinine may be demanded when the patient is weak and anæmic; and when there is great irritability of the urinary organs, with restlessness and wakefulness, opium, in the form either of Dover's powder or of morphia, will often be productive of the happiest effects. Among the mineral waters in common use, none is better adapted to the diathesis under consideration than Vichy water.

OXALATE OF LIME.—Oxalic acid, when existing in the urine, is found in combination with lime in two crystalline forms,—the *octahedral* and the *dumb-bell*. (Fig. 1366.) Though not forming a noticeable deposit, these crystals are often found entangled in the mucus which is seen floating in the urine.

The octahedral crystals when viewed with the microscope resemble (when seen in their long diameter) two quadratic pyramids with well-defined angles and with their bases applied against each other. Viewed in another position, these crystals exhibit a flattened or square figure. The *dumb-bell* variety,

much less common than the other, conforms in shape very accurately to the object after which the crystals are named. The mass resulting from a conglomeration of these bodies frequently constitutes the nucleus of a stone.

FIG. 1366.



Crystals of oxalate of lime.

The only two deposits with which oxalate of lime is likely to be confounded are certain of the triple phosphates and uric acid. Any doubt, however, which may arise on this subject can be readily removed by adding to the sediment a little acetic acid, when, if the deposit is made up of phosphates, the latter will be quickly dissolved; a solution of caustic potash will cause any uric acid which may be present to disappear: neither of these tests affects the oxalate of lime.

The manner in which oxalic acid is formed in the system and appears in the urine is undetermined. Some, as Böcker, assert that it is a normal constituent of the body. Schunk endeavors to show that it is formed from the oxalate of ammonia during the decomposition of urine, though Neubauer alleges that the decomposition of this substance, instead of producing oxalic acid, results in the formation of carbonate of ammonia. Prout refers the origin of oxalic acid to the imperfect digestion of saccharine vegetable matter. Rhubarb, sorrel, and other members of the vegetable kingdom are quite rich in this substance. Others, and among them Frerichs, assert that this acid is formed by the decomposition of uric acid and urates. There is reason to believe, from observations which have been made by experimenters, that oxalic acid may be derived not only from all the three groups of food (namely, the albuminoid, the fatty, and the saccharine), but also from the retrograde metamorphosis of various animal substances in the body. Oxalate of lime, or oxaluria, as the disease is often termed, is more common in men than in women. The symptoms which indicate the existence of this diathesis are of a dyspeptic character, as flatulence, fullness in the epigastrium, oppression on the chest, eructations of gas, and palpitation of the heart.

The nervous system is often profoundly implicated in the disorder; the patient becomes depressed in spirits, gloomy, hypochondriacal, often fretful, loses all interest in business, and is disqualified for any active employment. The sexual power is impaired, and in some instances entirely lost; frequent micturition may exist, and is attended with some heat, and probably with more or less scalding, while the patient steadily loses in flesh. Unless the condition of oxaluria is early recognized and corrected, it will result in the formation of calculus, and that of an exceedingly painful kind.

TREATMENT.—As oxaluria is closely associated with irregularities in the digestive organs, attention must be first given to a strict regulation of the diet. All vegetables and fruits containing oxalic acid must be avoided, as rhubarb and tomatoes; also those which are rich in malic, citric, or tartaric acid. All wines are to be eschewed, also beer, ale, and porter: if any stimulants are required, whisky or gin will be the least objectionable. Water containing lime is unfit to be used by a patient laboring under oxaluria, as it furnishes a ready basis for combination with oxalic acid. In limestone districts, in which the drinking-water is hard, it may be improved by boiling, though still objectionable, and it will be better to direct the use of distilled water, the insipidity of which may be removed by the addition of a little gin.

Attention to out-door exercise, to the condition of the skin, and to the

correction of any pulmonary, circulatory, or renal disorder, is as important in the general management of oxaluria as in the uric acid diathesis.

The tonics which have been found most useful in this disease are the mineral acids, as the nitric or the nitro-muriatic, and when these fail to make the requisite impression on the deposit, the acid phosphate of soda may in some instances be advantageously substituted.

PHOSPHATIC DEPOSITS.—Phosphoric acid is not found in the urine in a free state, but combined with alkaline and earthy bases. The alkaline bases are potash and soda, and the earthy bases lime and magnesia. Urine which is healthy contains very much more (about four times) of the alkaline than of the earthy phosphates. The deposition of phosphates spontaneously from normal urine does not occur, they being kept in solution. When, however, the secretion is exposed for a time to the air and fermentation commences, the decomposition of its urea into carbonate of ammonia begins, and crystals of the *triple phosphates* are precipitated, consisting of the *ammoniacomagnesian phosphates* and the phosphate of lime.

The *alkaline phosphates*, namely, the phosphate of soda, the acid phosphate of soda, and the phosphate of soda and ammonia, being very soluble, do not occasion deposits.

The spontaneous deposit of phosphates in fresh urine is no evidence that there is an undue elimination of these matters. Indeed, it may be evidence of the reverse condition. If the urine happens to be alkaline, the earthy phosphates, being insoluble in the secretion having such a reaction, are immediately precipitated; but if the reaction of the urine proves to be very acid, both the alkaline and the earthy phosphates may exist in great excess and yet no deposition occur. This fact should never be overlooked in examinations of urine.

These earthy phosphates are all quite insoluble in water, but soluble in acids. Heat will cause their precipitation. In this respect they resemble in behavior albumen, with which they are sometimes confounded. The addition, however, of a little acid, as nitric or acetic, soon dispels the delusion by rapidly dissolving the deposit, which would not occur if the turbidity was due to albumen. To ascertain approximately the amount of the earthy phosphates in a specimen of urine, it is only necessary to add a few drops of ammonia, when a light-colored precipitate will be thrown down, and one which will not be redissolved by heat.

The phosphatic deposits include three varieties, namely, the phosphate of lime, the triple phosphate of magnesia and ammonia, and the mixed phosphates, or those containing both the phosphate of lime and the triple phosphate.

1. *Phosphate of lime*, that is, the *earthy phosphate*, may appear either as an amorphous powder or in crystalline form, depending on the degree of rapidity with which the phosphate is precipitated, viz., rapid in the first and slow in the last form of deposit. The color of the sedimentary matter is whitish or gray. The crystalline portions exhibit prismatic, rosette, and spherical forms; the latter may, on a careless inspection, be mistaken for dumb-bells, because when two of these globules adhere, a slight constriction will be noticed at the point of conjunction.

2. *The triple or ammoniacomagnesian phosphate* appears as a deposit of minute white crystals. (Fig. 1367.) Other forms are also noticed, as fronds or feathers, disposed in stellate figures. This is the case particularly when the crystallization takes place rapidly, as when it is induced by the addition of ammonia to the urine immediately after its passage.

The iridescent film which is often seen floating on the top of the urine is made up of these crystals, with other products of the decomposing secretion. Urine containing these triple phosphates is usually pale, with a low specific gravity, and somewhat increased in quantity above what is normal.

3. *Mixed phosphates* are those which consist of a combination of the phosphate of lime and the triple or ammoniacomagnesian phosphates. The urine when thus constituted is abundant and pale, emitting an offensive

odor, and mixed very often with a quantity of ropy, vesical mucus, throwing down an abundant whitish, lime-like sediment.

CAUSES.—The amount of phosphates in the urine is influenced by food,

FIG. 1367.



Crystals of the triple phosphates.

drink, age, injury, and disease. Beef, potatoes, and bread yield a much larger amount than sugars, fats, and starchy substances. Persons living in limestone districts, where the water is strongly impregnated with lime, furnish a urine richer in phosphates than those who reside in districts where the water is soft. The urine of individuals advanced in life contains a much larger amount of these materials than is found in that from a young person. In injuries affecting the spinal marrow, as in fractures of the vertebræ followed by paralysis, the urine becomes so loaded with phosphates that the deposit has been mistaken for an accumulation of pus or muco-pus. The same is true in rheumatoid arthritis, in chronic cystitis, and in rickets. Every-

thing which makes large drafts on the nerve-tissue, as intense study or protracted grief, conduces to the same result; though there are some excellent authorities, and among them Beale, who do not give their unqualified assent to this statement. The long-continued use of alkalies, by changing the normal acid reaction of the urine, is also regarded as a cause of phosphatic deposits.

Accompanying this condition of the urine there are well-marked symptoms of disturbance both of digestion and of assimilation, as flatulency, eructation, abdominal distention, and emaciation, accompanied with fretfulness and depression of spirits.

Carbonate of lime sediments are not common. They occur in an amorphous form, sometimes mingled with minute spheroidal and stellated crystals. The addition of nitric acid dissolves the deposit with some effervescence.

TREATMENT.—Much attention must be given to correcting any irregularities of the digestive organs which may be found to exist. To this end the diet will require to be restricted, allowing only such articles as are found to produce neither gastric nor intestinal irritation. The bowels are to be regulated, if necessary, by laxatives; and, as an alkaline state of the urine is so prominently concerned in the production of these deposits, acids, as the nitric or the nitro-muriatic, should be regularly administered largely diluted. Tonics, as the tincture of iron and quinine, will sometimes prove of value, or if they are not well borne, as is not unfrequently the case, we may substitute with great advantage the compound infusion of gentian, with the tincture of nux vomica and dilute phosphoric acid.

Cod-liver oil, and the superphosphate of lime, are also valuable remedies, especially when the bones become affected, as in rickets. As considerable restlessness and general nervous excitement are always present in these cases of phosphatic deposits, opium becomes valuable as a means of quieting and disposing to rest.

CYSTINE.—This unusual deposit, first recognized by Wollaston, is remarkable for the amount of sulphur (26 per cent.) which it contains. It is found in both acid and alkaline urine, and forms when deposited a sediment of a whitish or dull yellowish-gray appearance, which, when subjected to a microscopic examination, exhibits six-sided crystals of different sizes and often one superimposed upon another. They bear some resemblance to crystals of uric acid, but are very much smaller. Should any doubt arise in the matter of distinction, it may be promptly settled by adding a few drops of a mineral acid,

which will produce no effect on uric acid, but will quickly dissolve the crystal of cystine. The urine which furnishes cystine is pale, and emits a sweet-brier odor, which is probably due to the commingling of sulphuretted hydrogen and ammonia. This substance is the principal constituent of the cystine calculus.

Cystine is insoluble in carbonate of ammonia, but soluble in potash. It is supposed to be formed in the liver, though nothing positive is known with regard to its origin. It is never found in the body in health. The cystine diathesis which underlies the cystine calculus is one in which the symptoms are so subjective as to pass unnoticed, the stone attaining considerable bulk before being recognized, so little uneasiness does it produce. A remarkable feature belonging to cystine urine is its entire independence of any other deposit.

TREATMENT.—Ignorant as we are on the subject of the origin of cystine, it is difficult to prescribe with any degree of confidence the treatment best adapted to correct the diathesis. It has been advised by Harley that in selecting the articles of diet all substances should be excluded which contain much sulphur, as eggs, peas, beans, and also protein substances, as albumen and fibrin, using in lieu thereof substances belonging to the saccharine, oily, and starchy groups. He would apply the same rule to the subject of drinks, which would exclude all mineral waters containing the sulphate of magnesia or of lime. The same objection would hold against citrates, acetates, and tartrates, none of which exert any solvent power on the cystine. As tonics among the mineral acids the nitric is to be preferred, and among the ferruginous class of remedies the tincture of the chloride of iron will be found to prove most efficacious.

In addition to the use of the above remedies, the patient should not neglect the advantages of judicious clothing and exercise in the open air.

Urinary Calculus.

Urinary calculus commences either in the kidneys or in the bladder. A very large number of all vesical calculi begin in the former, in consequence of a deposit of certain saline matters from the urine, as uric acid, urate of ammonia, or oxalates, which gradually coalesce and form a small mass or concretion. This in time is passed into the pelvis of the kidney, and from thence transferred along the ureter to the bladder, where, if not expelled from the viscus, it constantly attracts to itself the salts of the urine until it attains a sufficient magnitude to create the usual signs of calculus. The triple phosphates of ammonia and magnesia are very seldom concerned in the formation of renal calculi.

When stone forms primarily in the bladder, it is referable to one of the following causes, namely, *first*, a precipitation or deposition from the urine, induced either by abnormal alterations in the secretion itself, or by inflammatory changes wrought on the mucous membrane of the bladder; and, *second*, the presence of a foreign substance introduced into the viscus either accidentally or designedly.

Calculi which are composed of uric acid or of oxalate of lime have their origin almost always in the kidney. Those which originate in the bladder are generally phosphatic.

Stone in the bladder is not confined to any period of life. It may exist before birth, and is met with from infancy to extreme old age. A very large proportion, however, of urinary calculi occur early in life. In a collection of 8574 calculous patients,* 4986 were under twenty years, 748 between twenty and thirty, 438 between thirty and forty, 588 between forty and fifty, 685 between fifty and sixty, 772 between sixty and seventy, and 338 between seventy and eighty.

The collections of Civiale, Coulson, and Thompson in the aggregate amount

* Gross on Diseases of the Urinary Organs.

to 10,467 cases of calculi. In Civiale's collection 55.56 per cent. of the cases were in patients under twenty years of age, in Coulson's collection 71.20 per cent., and in Thompson's 60.42 per cent. Taking the three collections together, 62.33 per cent. were under twenty years of age. By the same plan of estimate, 12.96 per cent. were between twenty and forty years of age, 12.33 per cent. between forty and sixty, and 10.77 per cent. between sixty and eighty.

In 187 cases of lithotomy performed at the Medical Missionary Society's Hospital, Canton, and reported by Dr. Kerr,* 65 of the patients were under twenty years of age, 33 between twenty and thirty, 40 between thirty and forty, 22 between forty and fifty, 21 between fifty and sixty, 5 between sixty and seventy, and 1 between seventy and eighty. These estimates, however, are calculated to mislead, from the disparity which must necessarily exist between the different classes of patients when the number of each is contrasted with the entire population living at the same ages. Were the statistics based on this principle, a result the reverse of that exhibited would be shown. In other words, the tendency to calculous disorders would be found to *increase with advancing age*. The inaccuracy of all statistics with regard to the age of calculous patients will be further shown by the fact that the date has been fixed at the time the patient was operated on, though the disease may have existed several years previously.

It would appear, however, from certain observations made by Cadge, that locality has some determining influence with regard to the class of patients attacked. Thus, most of the patients who labor under stone in the midland counties of England are children, while in Aberdeenshire they are adults.

The frequency of stone in the bladder is modified by geographical conditions. In some portions of this country vesical calculi are much more common than in others. This is true of Kentucky, Virginia, Ohio, Missouri, Alabama, Maryland, Indiana, Pennsylvania, and Tennessee; while in New York, Georgia, North Carolina, South Carolina, Mississippi, Illinois, Arkansas, Wisconsin, Iowa, Texas, Louisiana, and most of the New England States stone in the bladder is not common. The same may be said of Mexico. In England stone is more common than in Scotland, and in Scotland it is more common than in Ireland. In Norway and in Sweden calculus is rare. Certain districts of a State will furnish more cases of calculus than others. Thus, a very large proportion of the cases of stone occurring in Pennsylvania are met with east of the Alleghany Mountains. Even in the city of Philadelphia the disease is more common in the former district of Kensington than in any other portion of the city. The district of Norfolk furnishes nine-tenths of all the cases of vesical calculi that occur in England. The northern counties of Ireland and Scotland furnish more cases of stone than the other portions of those countries. In Central Russia calculous disease is much more commonly observed than in other portions of the empire. It was thought by Allan Webb that India was exempt from this disease altogether, but it has been shown that calculus is there quite common. A single museum contains 300 specimens of calculi removed from natives in different districts of the country, while 554 operations of lithotomy were performed in six months in the Punjab and northwestern and central portions of the empire.

Carter states that in the Presidency of Bombay, or Western India, stone is more common than in the Southern, or Madras Presidency.

In China stone is confined almost exclusively to the province of Canton. Dr. Kerr states that missionary hospitals have been in existence for more than twenty years in Ning-po and Shanghai, and at Peking and Han-kow for eight years, which have been attended by thousands of patients, and yet not a single case of stone has been met with in any of these institutions.

The first lithotomy done in China was performed by the Rev. P. Parker, founder of the Medical Missionary Society.

* New York Medical Journal, 1871, p. 365.

Calculous disease is quite common both in France and in Germany, also in Egypt among the Arabs.

Females are much less subject to vesical calculus than males, in consequence, no doubt, of the shortness and great dilatability of the urethra, by which any deposit or concretion that may reach the bladder is readily discharged.

The liability to stone is supposed to be influenced in some degree by peculiarities of *race*. In the United States it would appear that the negro population enjoys a much greater immunity than the white. Of 443 cases of lithotomy performed in seven Southern States, only 63 were practiced on negroes and mulattoes,* while 380 were done on whites. The same immunity on the part of the negro in Central Africa was observed by Dr. Livingstone.

The formation of stone has been attributed to the geological conditions of the soil. Thus, it has been supposed by Harley and others to be favored by drinking the hard water of limestone districts; but a careful inquiry will show that it is quite as common in the freestone as in the limestone districts of those States which supply the largest number of calculi. In Pequea and Conestoga valleys, portions of Lancaster County, Pennsylvania, abounding in limestone, and where the water is very strongly impregnated with lime, calculi are rarely met with. Besides, it is difficult to understand how uric acid calculi, which constitute a large proportion of all stones, could be formed out of lime.

Too free indulgence in wine has been charged with creating a disposition to stone. Fortified and acid wines may possibly have some effect of the kind, by disturbing the function of the liver, but the purer quality of clarets, Bordeaux and Burgundy, and the wines of the Rhine do not appear to possess any such properties: on the contrary, there is reason to believe that an opposite effect is produced. If it is true, as is supposed by Liebig, that the bitartrate of potash, which is present in great abundance in these wines, is changed into the carbonate of potash while passing through the digestive organs, which would tend to preserve an alkaline state of the urine, such an effect would be explicable. At a large convention of wine-growers in France, the subject of rheumatic and gouty disease as a result of wine-drinking was made a matter of special inquiry, when it was found that the members of this body really enjoyed a remarkable exemption from any disorders of the kidneys or the bladder, and that among them were a large number of very aged men. No small importance has been attached to the effects of cold, rough weather, peculiar to districts along the sea-coasts, as predisposing to calculous disorders; but Mr. Cadge states that of 1500 stone cases in Norfolk, England, fewer came from the villages along the coast, where the cold is greatest, than from places inland; and in the United States, New Jersey, having so extensive a line of sea-exposure, furnishes very few cases of stone.

Stimulants which act strongly on the kidneys have been supposed to exert an antilithic effect; but that they possess no properties of this nature will appear from the frequency with which stone occurs among the inhabitants of Holland, who so largely and generally use gin.

The *most probable predisposing causes* for the production of calculous disorders must, I think, be referred to conditions of the nutrition resulting from derangements of the digestive organs, and produced by improper food or its defective preparation for the table, insufficient exercise, or exposure, together with unpropitious hygienic surroundings. The frequency with which the poorer classes suffer from stone would seem to favor such a supposition. I shall have occasion to refer to this subject again.

Nor must we overlook the influence of family tendencies to stone. Mr. Cadge, in his address before the British Medical Association, refers to several instances in support of this. Five times has he operated on brothers for

* Gross on Diseases of the Urinary Organs.

stone. He cites also the remarkable history of a calculous family reported by Mr. Hubbe, of Lowestoft. Three brothers were operated on; a fourth had stone; the fifth child died with symptoms of the disease; a female child was, at the time this record was made, suffering from vesical irritation characterized by bloody urine; the father and mother passed large quantities of lithic acid; the grandfather had also passed a stone; the grandmother passed seven calculi; the great-uncle had been cut for stone; six uncles, four aunts, and a cousin had attacks of gravel. Montaigne and his father both died from stone. The two Walpoles, Robert and Horace, and also their mother, suffered from stone.

Obstructions to the free escape of the urine, such as exist in stricture and in hypertrophy of the prostate, though calculated to oppose the passage of the urine, are not, in my experience, very often associated with vesical calculus.

Chronic inflammation of the bladder and atony of its coats conduce to the formation of stone; deposition of the earthy salts of the urine takes place, in consequence of a portion of the secretion being too long retained in the viscus, or from the reaction of the saline matter on the mucus which is secreted so abundantly in cystitis. The formation of stone, when the nucleus begins within the kidney, is doubtless due in many instances to a purely local cause altogether independent of geographical, dietetic, or other general causes. This is evident from the frequency with which calculous concretions are met with in the pelvis of one kidney, while nothing of the kind exists in the other.

CONSTRUCTION OF CALCULI.—In order to the formation of a calculus it is generally necessary that there should be some central mass, called a nucleus, around which the saline or organic constituents of the urine are deposited, the process being one chiefly of deposition and of crystallization, conjoined with a cementation of the particles by organic matters. Just what this organic matter is, and its mode of deposition, have not been definitely determined; at least there is a diversity of opinion on the subject,—some, as Marcet, believing it to be mucus; others, as Fourcroy, albumen; and others, again, fibrin or gelatin. Indeed, various organic matters, as blood, mucus, epithelial scales, pus, etc., may become incorporated with or entangled among the cohering particles of the inorganic salts of the secretion.

NUMBER.—The number of calculi varies greatly. In most instances they are solitary, though there may be several. Two, three, or four are quite frequently met with. In a patient I cut for stone in Ashland, Pennsylvania, there were over three hundred calculi, varying in size from a grain of shot to a cherry. The most remarkable instance of multiple calculi is that of Chief-Justice John Marshall, from whom Dr. Physick extracted over one thousand, their sizes varying from a grain of shot to a small marble. These stones are preserved among the calculi in the museum of the medical department of the University of Pennsylvania. The mulberry calculus is almost invariably solitary; generally, this is also true of stones composed of uric acid. The departure from this rule is met with most commonly in phosphatic stones.

SIZE AND WEIGHT.—Most calculi are about the size of a small hulled walnut, and in weight four or five drachms. From this standard, however, there are many deviations, from a concretion the size of a grape-seed to that of an orange. The largest calculus removed from the bladder by lithotomy in this country was one extracted by Dr. Dunlap, of Springfield, weighing twenty ounces. Morand speaks of a stone which weighed six pounds, and one of a like weight is mentioned by Kesselring. Uiterhoeven, of Brussels, has one in his possession which measures six and a half by four and a half inches.* Verduc mentions one which weighed three pounds and a quarter. A patient died in the Philadelphia Almshouse whose bladder was almost completely filled by a calculus the size of a very large orange.

* Hospital Gazette, December 13, 1879, p. 644.

Mr. Earle has recorded the history of a calculus the weight of which was forty-four ounces. Several others of like dimensions and weight are recorded in works on the subject.

There is no correspondence between the bulk of calculi and their weight. The latter is determined by the composition of the concretion. A calculus consisting of oxalate of lime will be much heavier than one of the same size the composition of which is phosphatic. A stone will weigh more immediately after its extraction than several days following, when it has become dry.

The dimensions of a stone do not depend on the time that it has remained in the bladder. In this respect there is a great want of uniformity, chiefly in consequence of the constitution of the calculus. Those composed of the triple phosphates frequently attain a very considerable bulk. This is not the case with stones which are composed of uric and oxalic acids.

CONSISTENCE.—The consistence of calculi, like their weight, depends on their chemical constitution. Thus, we find them in some instances soft and crumbling under pressure, like a mass of coarse mortar, while in other cases they possess the hardness and density of marble. There are other conditions besides that of composition which tend to influence the consistence of calculi, such as the manner in which the particles of the mass are held together, and the rapidity with which the stone grows. When these particles merely cohere like so many grains of sand, forming a concrete by a connecting bond of animal or organic matter, it requires but little force to break the mass down compared with that necessary to crush one the components of which are laid down in strata. The calculi which stand highest in the scale of density are those consisting of oxalate of lime; next, those composed of uric acid; and last, those formed of the ammoniaco-magnesian phosphates and phosphate of lime, or such as are constructed out of the triple phosphates.

When the stone increases rapidly in size, it has not the same compact structure as when the growth goes on more tardily.

FORM.—Urinary calculi differ in shape according to their position in the urinary passages. When situated in the kidney, they may assume the form of the pelvis or infundibula, their branches being moulded into the inequalities of the different parts so as to resemble a piece of coral. When fashioned in the ureter, they have an oblong shape. Vesical calculi are generally round, unless when multiple, in which case they may be flat, faceted, pyramidal, semilunar, quadrangular, or wedge-shaped.

Upon one occasion I removed three calculi from the bladder, each cuneiform in shape, and all very closely resembling one another.

The hypertrophied muscular fasciculi of the bladder also make their impressions on the periphery of a calculus. The form of the stone is determined in some degree by that of the nucleus. For example, if it is built upon the end of a catheter which has broken off in the bladder, the concretion will be elongated and cylindrical. Some of the more unusual forms are those having a dumb-bell shape, or having a body with branching prongs, or presenting the appearance of the stopper of a glass decanter. One of the last-named shape I removed from the bladder of an Englishman in Philadelphia, who had been cut for stone several years before in Wales. The first operation had been followed by a fistula, in the upper part of which the stem of this stopper-shaped stone had formed, and so completely fitted the opening that no water escaped from the bladder, in consequence of which the opening on the surface of the perineum had healed.

When the concretion forms in the prostatic sinuses it will probably present a multi-faceted appearance. A vesical calculus may have a prolongation extending into the prostatic urethra, or it may commence in the latter and grow into the bladder.

The exterior of the calculi may be smooth, even polished, if the stone is hard, and there are more than one present, the friction of their surfaces producing this condition.

More generally the external surface is rough or granular, and in the case of the oxalate concretion it is tuberculated or knotty like the exterior of a mulberry; hence the name, mulberry calculus.

FIG. 1368.



Calculus covered with sharp spines.

In other cases the surface may be mammillated, or have projecting spikes or prongs, or it may bristle with spines, resembling the chestnut-bur; a specimen of this form of calculus is in my possession. (Fig. 1368.) When a number of distinct spherical calculi become adherent, they form what might be termed the grape-shot figure. To these may be added the button, the kidney-shaped, and many other varieties.

COLOR.—The color of a calculus, while it does not reveal the interior composition, indicates the chemical constitution of its exterior. A white or grayish color belongs to the soft phosphatic stones; a dark green characterizes the oxalate; a yellow color, the cystic; the yellow, pale brown, or reddish brown, the uric acid; and the cinnamon shade, the xanthic oxide calculi.

ODOR.—The calculus when recently extracted, in addition to having a urinous smell, emits a distinct and somewhat peculiar odor, dependent, it is thought, on the composition of the stone: thus, we have described the ammoniacal, the sulphurous, the seminal, the terebinthinate, and the aromatic odor.

ARRANGEMENT OF STRUCTURE.—In order to exhibit the disposition of internal structure it is necessary to make a section of the calculus. Occasionally when thus exposed the whole interior presents a homogeneous appearance, which is an indication that the chemical composition of the mass is the same throughout, constituting the *simple calculus*. Or it may be made up of different constituents, intermingled without any orderly arrangement, forming the *compound calculus*. Much more commonly do we find that the material from which the stone is formed, whether homogeneous or heterogeneous in its chemical constitution, is arranged in concentric laminae of the same color or of different colors around a central body,—the *nucleus*. These laminae may present individually a uniformity of texture, or they may collectively exhibit crystalline lines radiating from the centre towards the circumference. The laminae, like the layers of woody fibres seen on making a transverse section of a tree, mark the alternating periods of activity and quiescence in growth or increase.

At one time the constitution of the urine is such that its salts are rapidly deposited, until a considerable crust or layer is formed on the stone; at another period, either as a result of medication or from natural causes, the true balance between the saline and watery components of the secretion is established, during which no deposition takes place; and in this way the stone is built up, and the lines of definition which mark the separation of the different laminae are produced, in some sense as the geological strata of the earth are constructed. As most calculi are of a mixed character, the strata usually present different colors.

Alternating calculi.—This heterogeneous structure reveals the different chemical states of the urine at different periods during the formation of the calculus.

The composition of the nucleus varies in different cases. It usually consists of a few grains of saline matter, generally uric acid and its salts; sometimes of oxalate of lime, aggregated together and forming a single mass, though it may be multiple. In a few instances it has been formed from a small coagulum of blood, of inspissated mucus, or of mucous and epithelial cells together. The nucleus is not unfrequently introduced into the bladder from without. In a case of stone which I cut in the University Hospital, the concretion had formed around a raisin which had entered the bladder through

a recto-vesical fistula produced by a chicken-bone, which in its descent through the lower bowel impaled the bladder, and, after entering that viscus, was discharged through the urethra. In another case of stone which I saw, the patient, a soldier, had been shot in battle, the ball entering the bladder and becoming the nucleus for the stone. Several examples of this nature occurred during the late American war. Besides the materials first enumerated, a great variety of articles have reached the bladder, either designedly or by accident, and have acted the part of nuclei, as peas, beans, pipe-stems, lead-pencils, tacks, straw, hair, corks, crochet-needles, bones, pins, needles; even foetal remains have found their way into the bladder, derived from the ovary, and have served as nuclei.

In calculi which are amorphous, or without crystalline form, the lamellar arrangement may be faintly visible, while the constituents of the layers are made up of cohering particles like an aggregation of grains of sand. In other specimens there is no evidence of stratification, the concretion resembling a mass of dry plaster or mortar, which crumbles to pieces on the application of slight pressure.

A stone may increase up to a certain size, and then remain a long time without further augmentation, through the constant use of antilithic remedies. Indeed, it is not improbable that when the process of deposition is suspended for a considerable period the stone may, through the action of the urine, lose its consistence and become measurably disintegrated. This is probably the explanation of the irregular gnawed appearance which some calculi present.

Nucleus.—The nucleus of a calculus is generally situated in its centre, is round, oval, or compressed, and when laid open on making the section of a stone presents often the same concretionary arrangement of laminae as the crust which incloses it, and may also possess the same diversity in chemical composition. This central body, which, from its magnitude and its apparent independence of all that is exterior to it, is usually regarded as the nucleus, may not have been the starting-point of the stone. A closer inspection will often detect a still smaller mass in the centre of the formation, which, borrowing a term from cell histology, might be designated a nucleolus, and which really constituted the true nucleus or the prime factor in inducing the subsequent deposition or crystallization. There may be one or more nuclei. Generally this body is firmly adherent to that part of the stone within which it is encased; though sometimes, when blood or a considerable layer of mucus covered its surface at the time the peripheral deposit commenced, it may, in consequence of the drying of these organic matters, be found loose (Fig. 1369) or entirely detached from the layers which surround it.

The nucleus does not necessarily possess the same chemical constitution as the stone which surrounds it. Thus, a uric acid calculus may have a nucleus of oxalate of lime, or the reverse may be the case.

In rare instances the calculus may have no nucleus; at least none may be seen when the stone is sawed open, though doubtless one did exist at the commencement of the concretion, but, being of an inorganic and unstable nature, as blood, mucus, or lymph, it had gradually disappeared, leaving no trace of its pre-existence except the small cavity which it originally occupied.

Chemical constitution and varieties of stone.—It is well established that the chemical constitution of calculus is much influenced by locality. For exam-

FIG. 1369.



Nucleus lying loose in an oxalate of lime calculus.

ple, Carter affirms* that in India 50 per cent. of all calculi consist of oxalate of lime. In England, in the collections of stones contained in the London College of Surgeons, in Guy's Hospital, and in the Norwich Hospital, the average percentage of oxalate of lime calculi is only 16.86. Dr. Hassall, of London, furnishes the composition of 1000 calculi, 372 of which consisted of uric acid alone, or mixed with urates or oxalates or phosphates of lime; 253 of fusible calculi of earthy phosphates; 233 of a mixed nature, as uric acid, oxalate of lime, and earthy phosphates existing in the different strata; and 142 of oxalate of lime. In Egypt about 12.5 per cent. of calculi are oxalate of lime.

It would seem that the vegetarian habits of a population, together with the copious perspiration incident to a hot climate, which carries off much organic matter that otherwise would escape as urates in the urine, may be prominently concerned in the preponderating production of oxalate of lime calculi of India,—an explanation which Carter himself gives,—while in England and America the large consumption of animal or nitrogenized food may explain the frequency of uric acid calculi.

VARIETIES.—The most common variety of stone is one composed of uric acid, first observed by Scheele in 1776, and constituting about one-fourth or one-fifth of all calculi. The color is usually brown, or brown with a shade of yellow or red. Occasionally it is of a whitish color, in which case there is an incrustation of amorphous urate of ammonia or of phosphate of lime. The form is oval or somewhat flattened, and the surface either smooth or covered with minute rounded elevations. (Fig. 1370.) When more than one calculus exist, their surfaces may be polished. These calculi vary in size from a coffee-grain to a pullet's egg.

When a stone of this character is divided, it will either exhibit a series of various layers, each quite uniform in its thickness and all concentrically arranged about a nucleus having a similar disposition of its components (Fig. 1371), or will be without distinct laminae, presenting a uniform or amorphous appearance either of section or of fracture.

In the first or concentric variety the interior has a crystalline appearance,

FIG. 1370.

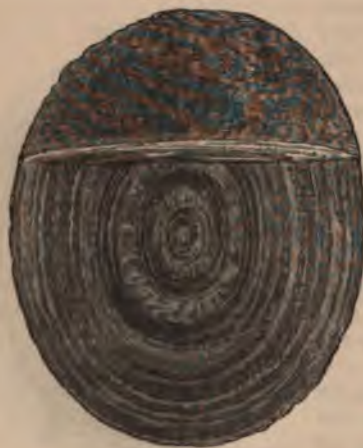


FIG. 1371.



The upper third exhibits the external appearance of a uric acid calculus; the lower two-thirds show the inner structure. Section of uric acid calculus, exhibiting interior.

the rays of fibres all converging towards the centre of the concretion. Some of these stones are exceedingly hard, the surface of the section resembling the interior of an agate, and when struck with the sound yield a remark-

* St. George's Hospital Reports, 1871-72.

ably clear, ringing sound. These calculi are soluble in carbonate of potash without evolving ammonia; also in caustic ammonia or potash; they disappear in nitric acid with heat, effervescing, and leaving, when the solution is evaporated to dryness, a residuum of a red color, which on the addition of ammonia is changed to a purple hue. Water produces no solvent effect on this calculus.

Urate of ammonia calculus.—This very rare stone, first recognized by Fourcroy and Vauquelin in 1798, never attains any great size; it is usually ovoidal in form, is smooth or granular on the surface, and is of a slate, gray, or clay color.

Urate of ammonia calculi occur about once in forty-six cases of stone. Thus, in an aggregate of 1043 calculi, 649 being in the museum of the Royal College of Surgeons, Edinburgh, and 394 in Guy's Hospital, there are 21 composed of urate of ammonia. These stones occur chiefly in children, are quite compact, not brittle, and are uniform in texture in consequence of the urate being generally deposited as an amorphous sediment rather than concentrically laminated.

This calculus is soluble in carbonate of potash, liberating ammonia, partially soluble in cold water, soluble in boiling water. A solution in water with a little ammonia, when evaporated, deposits wedge-shaped crystals, and when heated with caustic potash emits an ammoniacal odor.

Uric or xanthic oxide.—This substance was first discovered in a small calculus weighing only eight grains, by the elder Marcet, in 1815. Up to this time only four calculi of this kind have been reported. The stone is hard, on section presents a shining, brown appearance, and, though laminated in concentric layers, has no fibrous or crystalline appearance.

The xanthic oxide calculus is soluble in ammonia and in caustic potash, not crystallizing when evaporated. From its alkaline solutions it is precipitated by acids. It is insoluble in carbonate of potash, soluble with the aid of heat and without effervescence in the mineral acids, particularly nitric. Its solution in hydrochloric acid on cooling furnishes minute crystals (hydrochlorate of xanthin) visible only with the aid of the microscope.

Oxalate of lime calculus is next in frequency to the uric acid, forming about one-seventeenth of all stones. It was discovered by Wollaston in 1797, is generally of a dark-brown color, is very rough or irregular, and is tuberculated or spinous on the surface. (Fig. 1372.) It is this irregularity and the rich dark-brown appearance of the exterior of the concretion which have acquired for it the name of *mulberry calculus*. It rarely exceeds in bulk the size of a walnut. The peculiar tuberculation of the surface of this stone is supposed to be due to the constancy with which the oxalate maintains the crystalline condition during its deposition. In the interspaces between the prominences of this stone it is not uncommon to find deposited amorphous urates and phosphates. When the stone is divided, the interior presents a series of undulating or waving laminae with a central nucleus made up also of concentric layers.

This calculus is soluble in hydrochloric acid, and on the addition of heat effervesces. In mineral acids it is soluble, but without effervescence; insoluble in acetic acid; decomposed by sulphuric acid, giving off carbonic acid and carbonic oxide; and when a solution in a mineral acid is neutralized, it gives a white precipitate with carbonated alkalies and oxalate of ammonia.

There are three varieties of the oxalate of lime calculus. First, the small round, or oval, perfectly smooth stones, which from their resemblance to hemp-seed have been distinguished by the name of *hemp-seed calculus*. They are rarely solitary, generally multiple. The second variety is met with in the

FIG. 1372.



Surface of an oxalate of lime calculus.

condition of unmixed crystalline oxalate of lime; being almost entirely devoid of any cementing organic matter, it crumbles to pieces on drying or under pressure. The color of these concretions is pale yellow or brown. The third variety, first described by Mr. Charles Williams, of England, is exceedingly rare. The surface may be uniform, smooth, or irregular, though in the latter condition the eminences are free from any roughness due to the deposit of crystals. The chief characteristic of the concretion is its *snow-white* appearance, which is supposed to be due to its permanent habitat being in the pelvis of the kidney, where the stone is only slightly covered by the urine. The chemical and microscopic tests show that this stone consists entirely of pure oxalate of lime, being insoluble in potash and acetic acid, and displaying under the glass the characteristic octahedral crystals. Though all oxalate of lime calculi begin in the kidney, and subsequently pass into the bladder, in the few instances in which the present condition has been met with it has never been seen out of the kidney.

Cystic oxide calculus.—Another rare form of calculus is the cystine (Fig. 1373), only three of the kind existing among the 649 calculi contained in the

FIG. 1373.



Cystine calculus.

Hunterian Museum. Ten specimens are contained in the collection of Guy's Hospital, all passed by a single patient. Many surgeons of the largest experience have never met with a case. Civiale, whose great reputation in the department of stone surgery must have attracted a vast number of patients suffering from calculous disorders, met with only eight cases; and Gross says that no example of a calculus of this kind has occurred in his practice. This concretion was discovered by Wollaston, in 1805, and named cystic oxide, under the impression that it originated in the bladder (a supposition which has been found incorrect, as this calculus, like the oxalates, has its beginning in the kidneys). These concretions have irregularities over the surface, which may be either smooth or sharp. In structure there is an absence of orderly crystallization, the interior appearing somewhat transparent and in color and lustre very strongly resembling beeswax. These calculi do not attain any great bulk, the largest being in the University College Museum, London, and weighing 850 grains. The chemical peculiarity of the cystine calculus is the quantity of sulphur which it contains, amounting to one-quarter of its weight. Hereditary influences appear to be potential in the formation of this calculus. Mr. Poland mentions that out of a collection of 22 cases of cystine concretions, 10 occurred in four families, and in 3 the subjects of the stone-trouble were brothers.

The cystic oxide calculus is soluble in ammonia, crystallizing, when evaporated, in hexagonal plates, insoluble in carbonate of ammonia or potash, soluble in oxalic acid but insoluble in acetic and tartaric acids, soluble in both mineral acids and alkalies, but not affected by water or alcohol.

Phosphate of lime calculus.—A pure phosphate of lime calculus, for the discovery of which, in 1797, we are indebted to Wollaston, seldom occurs, the phosphate being usually mingled with other saline materials. Two varieties of this concretion are described, the first of renal origin, possessing a pale-brown color, a smooth, sometimes polished surface, and an oval form, and generally not of large size. It is arranged in concentric layers, which adhere to one another with but little tenacity, and are easily broken down, on account both of the soft, friable nature of the material, and of the large amount of organic matter which it contains. This variety is composed of a neutral phosphate of lime.

The second variety, more common than the first, is composed of phosphate of lime (bone-earth) aggregated into a granular mass; the particles, like dry mortar, are loosely bound together, and slimed over with organic matter, chiefly vesical mucus. This calculus is formed in the bladder. In both va-

rieties (the renal and the vesical) of phosphatic stones the concretion may have a nucleus of uric acid.

These calculi dissolve without effervescence in hydrochloric acid.

Ammoniaco-magnesian phosphate calculus.—This is a triple phosphate, and was discovered by Wollaston the same year (1797) in which was discovered that consisting of phosphate of lime. This stone has a white color; it is friable or soft in texture, non-laminated, exhibits no diversity of texture, but resembles a lump of chalk, and is covered on the surface with crystals. Concretions of this material frequently increase to a very large size. In a case occurring in the bladder of a female it attained the bulk of a goose-egg, and ulcerated its way into the vagina.

Fig. 1374 represents a calculus of this kind belonging to my private collection.

This stone dissolves in mineral acids, is not affected by caustic potash, dissolves in acetic acid with effervescence, and is very fusible under the flame of the blow-pipe, giving off an ammoniacal odor.

The mixed phosphate, or the fusible calculus, also discovered by Wollaston in 1797, is the most common among phosphatic calculi. It consists of three salts, the phosphates of lime, magnesia, and ammonia, and constitutes, it is believed, about one-twelfth of all calculi. The fusible calculi are chiefly due to an ammoniacal change in the urine, brought about by a pre-existing cystitis. These formations have a white or a gray color, and vary in form. They are very light and friable, crumbling, when firmly pressed, into a powder. (Fig. 1375.)

A section of a stone of this kind discloses in some specimens a concentric disposition of loosely-adhering laminae with interposed crystals of the triple phosphates; in others the laminated arrangement is absent; while in others, again, there exists a disorderly accumulation of crystals mingled with the other portions of the concretion.

The diversity of appearance presented by these calculi depends on the predominance of one or other of their triple constituents. When the triple phosphate is largest in amount the crystalline form will prevail, and when the cretaceous phosphate prevails the structureless appearance will be most noticeable. When a catheter is allowed to remain too long in the bladder, or when some foreign matter is introduced into the viscus from without, the incrustation which collects on either is composed chiefly of these triple phosphates. I have before me a mulberry calculus which is covered several lines in thickness with a snow-white deposition of these salts, particularly the phosphate of lime.

A solution of the fusible calculus in acid with an excess of ammonia furnishes a white precipitate, partly crystalline and partly amorphous, and fusible under the blow-pipe, leaving a white glass-like substance.

Carbonate of lime calculus, discovered in 1819 by Brugnatelli, is exceedingly uncommon. In all instances in which this form of stone has existed, the concretions were multiple, varying from five to forty-five in number. Stones of this substance are never large, rarely exceeding an almond in size. They are very hard, and possess both a lamellar structure and a serpentine arrangement of lines similar to those existing in the oxalate of lime calculus. Prostatic calculi have a similar structure. The carbonate of lime calculus is soluble in

FIG. 1374.



Ammoniaco-magnesian phosphatic calculus.

FIG. 1375.



Mixed or fusible calculus.

hydrochloric acid, in mineral acids, and in dilute acetic acid, effervescing with the latter, as also after heating. Besides the calculi already named, other concretions have been described, as the *fibrinous*, the *urostealith*, the *blood*, and the *silicious* calculi, all of which lack the true characteristics of stone.

The *fibrinous* concretion of Marcet and Prout is nothing more than a mass of albuminous or fibrinous matter, or some allied substance, in which the salts of the urine have become entangled, giving it a faint resemblance to crystallization.

The *urostealith* concretion is a body bearing some resemblance to fatty matter, though its exact chemical constitution has not been determined. All that is known with reference to this substance has been communicated to the profession by Heller,* and by Moore,† of Dublin, whose observations were made on a number of these concretions passed from the bladder of a young man who had previously complained of vesical irritation with lumbar pain. The largest of the bodies passed was about the size of a hazel-nut. When dry, the concretions were readily broken, presenting a wax-like appearance. On the application of heat they melted, disengaging an odor like that of benzoin. Ether and caustic potash dissolve urostealith, but it is not affected by either alcohol or boiling water.

Blood concretions, small dark bodies consisting of amorphous phosphates and blood-corpuscles mingled together and found in the pelvis or infundibula of the kidney, have been described by Alison.

SYMPTOMS.—A calculus, wherever formed, when once in the bladder, acts as a foreign body, and gives rise to a characteristic group of symptoms. Even before a concretion which may have been formed in the kidney has reached the bladder, there will be signs which announce that its descent is in progress, such as occasional attacks of nephritic colic. Many persons, however, carry for a long time in the bladder a calculus which may cause so slight inconvenience as to attract but little attention from the patient. This is most likely to occur when the surface of the concretion is smooth. In other persons, again, the symptoms of vesical irritation, at first quite urgent in the early history of a stone, may gradually subside. There are several conditions to explain this apparent anomaly, the most important being an *increase in bulk*, rendering the position of the calculus more stable; the filling up of surface inequalities by a new salt, thus rendering it less irritating to the mucous membrane of the bladder; and, last, the growing tolerance of the latter to the presence of the calculus.‡ A remarkable example of this occurred to Morand, who sounded a patient complaining of vesical distress, and detected, as he believed, a stone. The symptoms shortly after abating, it was supposed that the surgeon was in error. The patient before his death, which took place from another cause, sarcastically directed that his body should be handed over to Morand for examination, in order that the mistake might be established beyond peradventure. The post-mortem, however, proved that the surgeon was right, as three calculi were found, which had become smooth by attrition with one another. I once sounded a patient for stone who was suffering much from bladder irritation, and detected the concretion. Soon after the uneasiness disappeared so completely that no inconvenience was experienced for three years, when the vesical distress returned. I was again called, and removed four stones by the operation of lateral lithotomy.

The symptoms indicative of vesical calculus may be arranged under two heads, namely, the *rational* and the *physical*.

Rational signs.—Among the earliest of these is *frequent micturition*. The patient has frequent calls to urinate, particularly during the day, less frequently at night. He may be compelled to empty the bladder every hour or two hours, and in some instances every half-hour. When the desire to

* Heller's Archives, 1844-45.

† Dublin Quarterly Journal, May, 1814.

‡ Mémoires de l'Académie des Sciences, 1740 (Holmes).

evacuate the urine comes on, which is generally sudden, the inclination is irresistible and demands immediate obedience. The urgency of the symptoms will be conditional on a variety of circumstances, as the roughness or irregularity of the surface of the stone, the activity of the patient, enlarged prostate, riding over rough roads, extreme acidity of the urine, cystitis, urethral stricture, etc. The stream of urine is also frequently subjected to interruption; it at first flows freely, but after a time either begins to dribble or stops short and cannot be resumed until some device, as a change of position, is adopted. This interruption is due to the calculus being carried by the current of urine into the neck of the bladder and acting as a stopper. The obstruction is much more likely to occur in the early period of stone, when the concretion is small and therefore easily swept forward by the water. After the calculus has acquired considerable bulk, it is less prone to change its position. In some cases where the stone is small it becomes impacted in the neck of the bladder, and requires instrumental means for its dislodgment. It is true that frequent micturition is not peculiar to calculus. It may be produced by prostatic disease, by cystitis, urethritis, stricture of the urethra, emotional and other causes, and consequently of itself has only a limited diagnostic value. But on a careful analysis of many of the cases in which it is present, there will be found pre-existing or concomitant conditions which rarely lead to a false deduction. If it has been preceded by or accompanied with an attack of renal colic, or if the patient has passed gravel, the value of these symptoms is increased.

Pain is another important and early symptom of stone in the bladder. It is often very severe, darting and burning in its character, and is experienced during micturition, but most acutely at the termination of the act, when the collapsed walls of the bladder grasp the calculus. It is felt almost always near to or a short distance behind the external urinary meatus, and will often continue until enough urine collects in the bladder to distend its walls sufficiently to remove them from contact with the stone. To relieve the suffering from this source, the patient acquires the habit of constantly pressing and pulling the head of the penis with the fingers, which in time has the effect of increasing the size of the organ and elongating the prepuce. Both micturition and pain are influenced by alterations in the constitution of the urine; calculi are generally made up of strata having a different chemical composition, and, as some are less irritating to the bladder than others (for example, a rough oxalate of lime concretion, as a rule, occasions much greater suffering than a smooth uric acid or a phosphatic calculus), we have an explanation of those singular cases in which a patient suffers for a few weeks or months with active symptoms of stone and then enjoys even a longer period of comparative freedom from vesical uneasiness. Another and very common cause of these exacerbations of pain and micturition is active exercise, as riding over rough roads, by which the foreign body is rolled about in the bladder. Fecal accumulations in the rectum, exposure to cold and dampness, ulceration or abrasion of the mucous coat of the bladder, gouty or rheumatic states of the system, the use of alcoholic drinks, and peculiarities of temperament are all conditions which excite periodical aggravations of suffering. A stone may become fixed to a particular spot in the bladder, either by an inflammatory adhesion or by lodging in a pouch or diverticulum of the viscus; or it may become heavily coated with organic matter; and thus in the first case through fixation, and in the last through the filling up of all those inequalities on the surface of the concretion which tend to irritate the mucous membrane, the patient may experience comparatively little inconvenience.

Lastly, where calculi occur in a paralyzed or atonic bladder, both pain and micturition are subordinate symptoms, as little or no voluntary expulsive power remains in the walls of the bladder.

Pain is often felt in cases of stone in parts both contiguous to and remote from the bladder,—a fact which has its explanation in the nervous communications which bind together different parts of the body. Thus, in addition

to the distress at the end of the penis, a patient may complain of severe neuralgic pains in the rectum, down the thighs, in the back, over the hip, along the side of the body, and even in different parts of the arm.

Though pain is experienced in cystitis and in disease of the prostate body, there is a significant distinction between that resulting from those affections and that resulting from stone. In the former it is always experienced just *before*, and not after, urination.

CHANGES IN THE APPEARANCE OF THE URINE.—These consist in the presence of muco-pus, or of blood, in the secretion. Though it is possible for stone to exist for some time without a trace of either of these products, in the large majority of instances one or the other or both may be detected. If muco-pus, it is the effect of cystitis, and settles to the bottom of the vessel containing the urine. Blood, when observed, can generally be referred to some cause which rolls the calculus about in the bladder and produces a lesion of some of the capillary vessels of the mucous membrane. It may also follow a vigorous contraction of the walls of the bladder upon the calculus. This symptom is much less common in childhood than in mature or advanced life. The blood rarely exceeds a few drops, which are discharged with the last portion of urine. When more abundant, it will impart a mahogany or smoky appearance to the secretion.

Tenesmus, both vesical and rectal, is another sign attending calculus of the bladder.

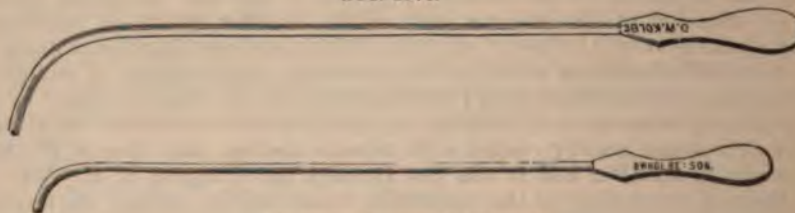
It is quite common in children, less frequent in adults. The patient during and after urination experiences an irresistible desire to strain, with a fullness in the hypogastrium and bearing down in the rectum. This is often followed by prolapse of the mucous membrane of the rectum in children, and by hemorrhoids in the adult.

Priapism is a frequent attendant on stone, particularly in children, and is excited by irritation reflected from the bladder to the cord. Urinary incontinence is sometimes observed both in children and in adults laboring under calculus.

Physical signs.—A patient with a group of symptoms similar to those that have been detailed, or if only the symptoms of frequent micturition and pain at the end of the penis are present, should be examined by a steel instrument called a sound; whence the term "sounding" given to the procedure.

Sounding.—Sounds are instruments resembling somewhat in shape the ordinary catheter. They are made, very unnecessarily, of several different curves, some of which, from their length, are utterly useless. They should consist of solid steel, nickel-plated, and should be about twelve inches in length, with a handle perfectly smooth, and the vesical extremity with either a slight or a short, abrupt curve, in order that the point can be carried into the depression behind the prostate, or into any other part of the bladder. (Fig. 1376.)

FIG. 1376.



The two curves necessary for sounds.

Two sizes only are required; the one suited to the adult, No. 13, and the other adapted for the urethra of a child, No. 9 or No. 10, on a scale 30.

Sounds are sometimes traversed by a small canal, through which fluid may be injected into the bladder. Mr. Napier has recommended pewter oxidized by nitric acid as a suitable metal for sounds; the object being to furnish a

surface which cannot be easily scratched by being brought into contact with a hard substance like stone.

The principle of the telephone has also been applied to the operation of sounding. I can conceive, however, of no material or mechanical contrivance better adapted to the object in view than the solid steel sound constructed after the plan already described. The directions preparatory to sounding usually laid down with some minuteness by authors, with regard to cleaning out the bowels by cathartics or an enema, and injecting into the bladder a certain amount of water, provided the urine has not been retained, are seldom carried out strictly in practice. Nor, indeed, is it necessary that they should be, except in cases where, notwithstanding the existence of symptoms of stone, some difficulty has been experienced in discovering the concretion. In these cases all these preliminary measures are not only proper, but necessary. Under such circumstances I prefer to make the exploration with the bladder very slightly distended, as the instrument has a smaller field to traverse. In children, in consequence of the fear, struggles, and cries which the act of sounding excites, the operation should be done only while the little patient is under the effects of ether.

During the examination the patient should be placed upon the back, near the edge of the bed or the table, with the shoulders raised, the knees somewhat drawn up, and the limbs separated, thus relaxing the abdominal muscles. The surgeon, standing on the left side if right-handed, or on either side if ambidextrous, now warms the sound at least to the temperature of the body, oils it, and, after inserting the point into the urethra, conducts the instrument gently onward into the bladder, in the same manner as in introducing the catheter.

Very frequently the stone is felt as soon as the sound enters the bladder, but if not, then the instrument is to be moved forward and backward, to the right and to the left; and if still unsuccessful in the search, it should be rotated on its axis, turning the point of the sound towards the *bas-fond*.

When the stone is struck, not only will the contact of the instrument with the surface of the concretion be felt by the hand, but by repeated taps a distinct clink or metallic sound will be heard, and this can be rendered still more audible, so as to be heard over a large room, by screwing to the handle of the sound the sounding-board of L'Estrange. (Fig. 1377.)

FIG. 1377.



Sound, with sounding-board attached.

Too much importance cannot be attached to the testimony furnished by the ear: it is far more reliable than the sensation communicated to the touch.

If all the circumstances attending those errors of diagnosis, in consequence of which patients have been cut without a stone being found in the bladder, could be learned, I have no doubt it would be found that the operator proceeded more on what was felt than on what was heard. The clearness, distinctness, or pitch of the sound elicited on striking a calculus will depend on the physical and chemical character of the concretion, and also upon its magnitude: a hard, compact calculus composed of uric acid or oxalate of

lime will yield a more positive ring than one consisting of softer material, like the phosphates, and a stone the size of a walnut will give out a clearer ring than one the dimensions of which do not exceed those of a grain of coffee. All the manipulations attending the use of the sound must be conducted with the utmost gentleness and care. Otherwise serious injury may be sustained by the bladder, causing peritonitis, acute cystitis, or even death, instances of which are recorded by Civiale, Sanson, and others.

Sources of fallacy arise sometimes from a fasciculated condition of the bladder, in which, as the point of the instrument is swept over these ridges, there is imparted a sensation which counterfeits in some degree that caused by a stone. But let it be remembered that in such a state of the organ the ear never detects any sound. A more embarrassing state is that in which the interior of the bladder is incrustated with the salts of the urine, in which case it is possible not only to feel but likewise to hear the contact between the instrument and the deposit. This condition, however, produces a grating sound rather than a click, and offers a more extended surface to the instrument than would be furnished by a calculus. A surgeon may also be led astray by causes which are entirely extra-vesical, as an unusual salience of the promontory of the sacrum, bony growths developed from the bones of the pelvis and encroaching on the walls of the bladder, induration of the prostate body, and fecal impaction of the rectum. In one instance the head of the femur protruding into the bladder was mistaken for vesical calculus.

Error may also arise from the presence of a vesical growth, the surface of which becomes coated with a deposition of phosphates. In the case of a female who presented all the rational symptoms of stone, the existence of which was verified, as I supposed, by the sound, I found, on making a digital exploration of the bladder, that the patient was laboring under a papilloma which had become encapsulated by a saline deposit. Even in cases of this kind, however, there is an absence of the true calculus ring, with a greater sensation of roughness than belongs to stone.

There are several *sources of difficulty* in detecting a calculus.

First. The depth of the post-prostate pouch of the bladder (Fig. 1378) may

FIG. 1378.



Sounding for stone in the post-prostate pouch of the bladder.

FIG. 1379.



Sacculated stone.

render it impossible to carry the sound to its bottom. The remedy consists in introducing a finger into the rectum, and raising this part of the viscous, so as to meet the reversed extremity of the sound; or the stone may be dislodged from its bed by placing the patient on his elbows and knees, with the pelvis well elevated.

Second. The stone may be imprisoned in a side pouch or sac of the bladder (Fig. 1379), or may be encysted, and thus elude detection.

When this is suspected, the organ should be distended with a fluid, and its walls explored in detail by straight as well as by curved sounds. I had an

opportunity of verifying the existence of a very peculiar variety of encysted calculus in a man over seventy-five years of age, on whom I performed lithotomy. The dull, negative sensation imparted to the hand on sounding was satisfactorily explained on opening the neck of the bladder, when the stone, fully the size of a walnut, was found immovably fixed to the mucous membrane, from which I failed to dislodge it on the application of the forceps. On withdrawing the latter and introducing my finger into the bladder, in order to ascertain the source of the difficulty, I was surprised to find the calculus completely invested with a membrane.

Drs. Hunt and Hunter, who were present at the operation, had an opportunity of confirming the existence of this membrane by the touch; and it was only after lacerating it and shelling it off that I succeeded in removing the calculus.

Third. There may be congenital malformations in which the bladder is divided into one or more compartments, and where a calculus might defy detection.

Fourth. The stone may be caught in a fold of the bladder, owing to some eccentric behavior of a certain group of muscular fibres, so as to conceal its location. Varying the position of the patient, distending the viscus with tepid water, and repeated soundings, offer the most reasonable prospects of success in detecting the presence of a concretion thus held.

Fifth. The bladder may be so fasciculated and the calculus so small that the latter may become caught in one of the intermediate depressions on the surface of the organ, and thus be overlooked.

Sixth. A calculus may be suspended by a thread of lymph from the summit of the bladder, as in Morton's case, and thus escape detection.

Seventh. There may be a partial anteversion of the bladder, and the stone be lodged against the anterior wall of the latter, behind the pubes. To touch a calculus so situated would require the handle of the sound to be strongly depressed between the thighs of the patient, with the concavity of the curve upward, in order that the point of the instrument should be directed to the proper place. (Fig. 1380.)

Eighth. Indifference on the part of the surgeon to the sensations of the patient may give rise to error. A most instructive instance of this kind came under my observation a few years ago. A patient from Western Pennsylvania visited Philadelphia, in order to be relieved of a vesical calculus. Several surgeons who examined the man had failed to touch the concretion, though he himself affirmed that he had frequently felt it while using the catheter to relieve the bladder, and that he could tell with entire certainty when the stone was tangible by certain sensations which he experienced, and which he described as those of a body "rising up" in the viscus. On his arrival in the city he was examined by a surgeon, who decided that the bladder contained no calculus. When the patient applied to me, I listened attentively to his story about the rising up of the stone, and his inability to convince those who had unsuccessfully explored the bladder that it was impossible to feel the foreign body at any other time. While he was describing the peculiarities of the case, he suddenly cried out, "The stone is rising!" I immediately introduced a sound, and detected two calculi, which were afterwards removed.

The bladder appears to have the power in some rare instances of changing its form, so as at one time to conceal calculi from the most painstaking

FIG. 1380.



Stone lodged against the anterior wall of the bladder.

search, and at another to eject them from their hiding-place, so that they can be touched even by an unskillful hand. Repeated explorations alone can overcome this difficulty.

Ninth. Hemorrhage in the bladder may frustrate the efforts of the surgeon to detect a stone, as the coagulated blood adherent to its surface so neutralizes sensations resulting from the contact of the sound with the concretion that no definite opinion can be formed.

Tenth. Calculi may dilate the ureter into a great pouch immediately behind the bladder, and give rise to the same symptoms as those of vesical calculus, yet it would be impossible to touch them with the sound. In two instances I have seen crowded together in a dilated ureter a large accumulation of stones, which, until revealed by an autopsy, were only suspected to exist.

Eleventh. The calculus may be buried in the prostate body, or the latter may be dilated by disease into a large sac, in which a stone may be hidden away out of reach of the sound. Or the urethra itself, near the bladder, may become converted into a pouch, through which the point of the sound may be freely swept, thus leading the operator to suppose that he is in the bladder when he is not.

Twelfth. A stone may occasion so little inconvenience that its existence will not be suspected. Cases are on record, as those of Van Helmont, Deschamps, Johnson, of Richmond, and others, in which the calculus has attained extraordinary dimensions without giving rise to any symptoms, until by some unusual jar or jolting the concretion became disturbed, after which the usual signs made their appearance. In three cases I have seen calculi removed from the bladder after death, one of which was the size of an orange, where, so far as I could ascertain, their presence had not been suspected. The passive behavior of these foreign bodies is probably to be accounted for by the smooth character of their exterior, and by their remaining fixed in one locality.

EXPLORATION OF THE BLADDER FOR STONE IN FEMALES is best effected by a straight sound: in order to avoid all sources of error from uterine disease, or from vesical growths incrustated with the salts of the urine, pressure should be made on the bladder at the same time through the vagina and above the pubes, or, should there remain any obscurity after the use of this means, the bladder should be subjected to a digital exploration, the patient having been previously placed under an anæsthetic.

Not only do we ascertain the existence of stone in the bladder by sounding, but it is possible also to learn something about the size and consistence of the concretion, and also the tolerance of the organ for the use of instruments. The high-pitched click which follows the tap of the sound against a calculus signifies a *hard* stone, perhaps one of uric acid or oxalate of lime, and by carefully passing the front of the instrument over the concretion in different directions a rough estimate may be formed of its bulk.

Measuring calculi.—It is desirable to have a knowledge not only of the probable composition of the stone, but also of its dimensions, as the method of dealing with the foreign body will be largely determined by the possession of such information.

By introducing a lithotrite into the bladder and catching the stone between its jaws the diameter of the concretion may be ascertained, and not only so, but an examination of the fragments which cling to the blades on their withdrawal will furnish some clue to its composition.

Sir Henry Thompson has very ingeniously substituted for the lithotrite in measuring a calculus an ordinary sound with a ring or collar, which can be made to slide along the shaft. (Fig. 1381.) In the application of the instrument, the latter is inserted into the bladder, and its end passed over the surface of the stone by a succession of taps, until the extreme limits of the body have been traversed. The collar is then to be slid down the shaft of the instrument until it touches the meatus, when the sound must be drawn back over the calculus, tapping the latter until its surface has been passed over.

the distance between the penis and the collar expresses the diameter of the concretion. The test, unless made with a delicate hand, must, however, be accepted with some distrust.

Notwithstanding the accurate information conveyed by the sound, it some-

FIG. 1381.



Thompson's sound for measuring a calculus in the bladder.

times leads the surgeon astray, or at least the sensations which it communicates may be wrongly interpreted. In this way even the most distinguished and experienced lithotomists have been led to subject patients to operations for stone where none existed in the bladder. Three times Cheselden was deceived by his sound, and cut without finding any calculus in the bladder. Dupuytren, Roux, Tyrrel, and others have committed similar mistakes. Three times have I known the operation of lithotomy performed without any stone being found.

The constitutional symptoms of stone are subject to considerable variation.

Persons in middle and advanced life suffer more than children. Indeed, the latter may carry stones for years without exhibiting any material loss of health. In calculous patients of riper years there is a tendency to chronic cystitis, and also to disease of the kidneys; the constant calls to urinate, the loss of sleep, and the deteriorated state of the blood, which the renal organs in their crippled condition are unable to depurate, soon begin to undermine the health. The digestive organs become deranged, the patient loses flesh and strength, and finally, if the disease is allowed to progress without interruption, he perishes, after enduring years of suffering, worn out with hectic, or perhaps suddenly in a convulsion.

PATHOLOGICAL CHANGES.—The alterations of structure which frequently follow the presence of stone are often very extensive and wide-spread, and depend on the propagation of local irritation from the mechanical effects of the calculus. They begin in the bladder as a cystitis, and present the usual characteristics of chronic inflammation of that organ, viz., increased vascularity of the mucous coat, submucous infiltration, and thickening, finally amounting to hypertrophy of the other tunics of the viscus, and occasionally ulceration of the mucous membrane.

Twice have I known in females the ulceration to extend through the walls of the bladder and the stone escape into the vagina. It is more serious when, in the male, it enters the recto-vesical space, where it may occasion death from urinary infiltration. The inflammation is propagated to the ureters, in consequence of which they undergo thickening, contraction, sometimes dilatation, and occasionally ulceration.

The kidneys also participate in the evil, becoming inflamed, and exhibiting in a few instances the usual appearances of Bright's disease, or more commonly undergoing suppuration, during which they become filled with abscesses, and perhaps are finally converted into a large sac containing numerous calculous concretions. The inflammatory changes may also extend to the vesiculæ seminales and the seminal ducts, the walls of which, like the ureters, are liable to become dilated or thickened, and contracted. The vesical irritation sometimes extends to the cellular tissue of the perineum, or may result either in a fistula or in abscess: I have witnessed both of these conditions in the last twelve months. The urethra is less disposed to become involved than the urinary tract higher up, the morbid changes being confined chiefly to the prostatic portion, and consisting for the most part in an undue vascularity and thickening, which contribute in no small degree to increase the sufferings of the patient by provoking increasingly frequent micturition.

The prostate body rarely escapes unharmed, becoming enlarged, and offering considerable obstruction to the escape of urine. Changes may also take place in its structure.

The plexus of veins at the neck of the bladder exhibits considerable dilatation, becoming contorted and varicose, and often gives rise to troublesome bleeding after lithotomy.

A calculus in the bladder has presented an obstacle sufficiently great to defeat parturition. An interesting case of this kind, recorded in the "New York Journal of Medicine and Surgery" for September, 1850, and reported by Dr. Monad,* demanded the removal of the stone before the labor could be completed. A similar case was seen by Mr. Threlfall,† one of the surgeon accoucheurs to the Liverpool Ladies' Charity, in which a calculus weighing six ounces was mistaken for a scirrhus of the right ovary. The patient perished from exhaustion without being delivered.

Spontaneous rupture of calculi has been known to happen, produced, no doubt, by their being rudely driven together when multiple; also by the explosive action of gas generated within the concretion; possibly also by the spasmodic contraction of the bladder around the stone. An accident of this kind is possible only with a soft concretion, and is one of great danger: as the sharp angles of the fragments frequently wound the walls of the organ, and excite acute cystitis, ulceration and perforation of the bladder, urinary infiltration, peritonitis, and death.

Treatment of Vesical Calculus.

The treatment of stone in the bladder is embraced under two heads, namely, *general or constitutional*, and *local*.

The constitutional treatment aims at palliation, not cure, and consists in prescribing a regimen which will tend to correct all errors of digestion, and those remedial agents which through the urine are capable of exerting some influence on the stone. The patient must use only those articles of food which experience has shown to be most easily digested. It is almost impossible to designate the exact articles proper in every case. What will suit the stomach of one person may not agree with that of another; but generally broiled or roasted meats, eggs, rice, white potatoes, stale bread and biscuit, buttermilk, oatmeal, hominy, and milk constitute the best pabulum; while salt meats, fried or stewed meats, fats, gravies, dressings, sugars, sweet potatoes, onions, warm bread, pastry, sour fruits, sweet cakes, or highly seasoned food of any kind, together with wines or other alcoholic drinks, will be productive of harm. In persons addicted to the use of stimulants, and who seem to suffer from their withdrawal, the least objectionable of the class allowable are sound cider and Holland gin. Drinking-water which may be impregnated with lime should be proscribed, as its use will furnish the materials which go to increase the calculous disorder; and in the event of the patient being so circumstanced that only hard water can be obtained, before being used it should be subjected to boiling, by which the contained salts can be largely removed. The relation which the skin and the respiratory organs sustain to the kidneys in the work of eliminating the products of oxidation renders it important to secure the healthy operation of both; and to this end the body must be warmly clothed and defended against cold and moisture, and gentle exercise taken in the open air during pleasant weather, though all rough and jolting movements are to be avoided. Abstinence from sexual indulgence should also be observed, as an aggravation of all the vesical symptoms is liable to follow any violation of this rule.

The medicinal agents which can be given with the greatest benefit are those which have the effect of preserving the urine in its normal neutral state. The free use of water alone, by furnishing a solvent, performs a valuable office in preventing urinary deposits. The patient can add much to his

* London Medical and Surgical Journal, vol. ii., 1829.

† Ibid.

own comfort if properly instructed by his medical attendant. Whenever the urine yields an acid reaction to test-paper, alkalies are indicated; and when it becomes alkaline, acids are required. The alkali which in my own experience has given the greatest satisfaction is the bicarbonate of potash. Thirty grains of the salt dissolved in a pint and a half of water should be taken by installments in the course of every day. The liquor potassæ, provided the stomach is not disordered, may sometimes be substituted for a short time. The various nostrums which have been in use at different times for the cure of calculous disorders consist chiefly of alkaline substances. Thus, the famous antilithic of Mrs. Stevens, purchased in 1739 by the English government for five thousand pounds, at the suggestion of a committee appointed by Parliament, consisted of castile soap and calcined egg-shells; that of Lee is probably nothing more than the bicarbonate of soda with castile soap and the oil of juniper. I am sure the health is often seriously damaged by the prolonged use of these remedies. They should not be employed continuously for a longer period than eight or nine days.

When the calculus is composed of the oxalate of lime or is of a phosphatic nature, alkalies are contra-indicated, the mineral acids being preferable, particularly the nitro-muriatic, in doses of four or five drops largely diluted three or four times a day. In the use of alkalies some caution is necessary.

Certain waters, notably the Vichy, enjoy a considerable reputation in cases of stone; and it is no doubt true that in view of their alkaline constituents they may be used with some relief. I think it probable, however, that the quantity of the water has more to do with the benefit derived than its composition.

When the health is broken by the long-continued irritation resulting from the presence of vesical calculus, preparations of iron and quinine will be demanded. Opium suppositories also, during exacerbations or fits of calculous disorders when more than ordinary distress is experienced, will exert a salutary effect in quieting irritation and procuring sleep.

Local solvents.—Although the theory of dissolving a stone by the direct application of certain reagents passed into the bladder is a very attractive and plausible one, its practical application has not met with the success which was anticipated. The concretions which have been most influenced by the local use of solvents are those of phosphatic origin, and it was in cases of this nature that Sir Benjamin Brodie and Mr. Southam each succeeded in effecting a cure. The agent employed was nitric acid (two and a half minims to one ounce of distilled water); the liquid was passed over the concretions by means of a double catheter for about twenty or thirty minutes. The acetate of lead has been used for the same purpose and in the same manner by Dr. Hoskins (one grain of the salt to one ounce of water). The new combinations which follow from the interchange of constituents, namely, the phosphate of lead and an acetate of lime and magnesia, do not cause any vesical irritation, and as the former is precipitated in the form of a fine sediment, it may be washed out of the bladder during urination.

The solvents, of course, must vary with the character of the stone. For uric acid calculi, alkaline solutions are required, as the liquor potassæ greatly diluted; for oxalate of lime concretions, and for those composed of the triple phosphates, dilute acids constitute the proper solvents: for the first, nitric acid; for the second, hydrochloric acid. To produce any decided change, however, in a calculus, especially one having an oxalate of lime or a uric acid composition, these substances would require to be employed of a strength which could not fail to produce a corresponding effect on the mucous coat of the bladder, and hence they are altogether improper to be used, so that the question of solvents for the cure of stone in the bladder has very little to recommend it to the attention of the profession. The same may be said of the electrolytic mode of disposing of urinary calculi recommended by Bouvier, Gruithuisen, Bonnet, O'Shaughnessy, and others, and put into practice by Dr. Bence Jones and Dr. L. Melicher. A grooved battery with twenty

airs of plates was employed for the purpose in the experiment of Jones, who used a solution of the nitrate of potash, from the decomposition of which was obtained the nitric acid liberated at the positive pole of the battery; this was to decompose the uric acid of the stone, while the potash liberated at the other pole was to cause its solution. What may be the ultimate results obtained in this department of electrolytic surgery it is impossible to say, but at present its claims to professional confidence are very slight indeed.

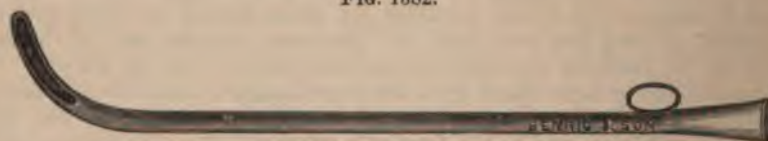
Extraction of Calculi.

There are three ways in which a calculus may be removed from the bladder: *first*, by its spontaneous discharge through the urethra; *second*, by extraction with forceps by the operation of lithotrity, in which the stone is ground to pieces, and is either allowed to escape with the urine or is washed out by suction; *third*, by lithotomy, in which an incision is made through certain portions of the body offering a convenient route to the bladder.

First. The spontaneous expulsion of stone is a common event, but when it occurs the concretion is usually quite small, at least in one of its diameters. Cylindrical calculi even one inch in length sometimes escape from the bladder in this manner.

After attacks of renal colic, systematic efforts should always be made to favor the passage of the concretion should it have entered the bladder, for if allowed to remain it soon becomes the nucleus for a stone. Should the gravel not be discharged in a few days after the paroxysm, its escape will be promoted by dilating the urethra to its fullest capacity with graduated bougies. After this has been done, the patient should be requested to retain his urine until the bladder becomes well distended, when it should be emptied with vigorous energy while he is on his hands and knees. In this posture some advantage is gained from the force of gravity pitching the stone forward into the neck of the bladder. Another plan may be adopted, should the last fail, namely, that of grasping the glans penis and by forcibly closing the external urinary meatus preventing the escape of the urine until the canal is well dilated by the column of water, when the pressure should be suddenly removed, at the same time the strongest voluntary efforts being made to empty the bladder. In this manner, the concretion is swept onward by the stream of urine, and, meeting with little resistance from the walls of the dilated urethra in front, may be expelled safely from the body.

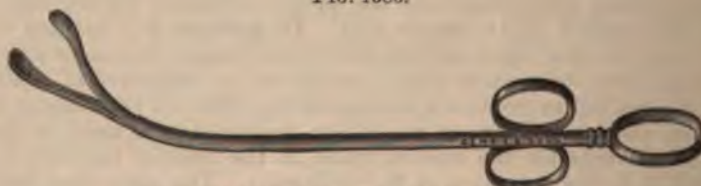
FIG. 1382.



Catheter for removing calculi.

Instrumental extraction.—Two instruments have been devised for extracting calculi entire from the bladder of the male,—the one a large catheter with an

FIG. 1383.



Forceps of Sir Astley Cooper for seizing vesical calculi.

ample eye at the vesical extremity (Fig. 1382), and the other a peculiarly-shaped forceps. (Fig. 1383.) This method appears to be an old one, having

been quite familiar to the Egyptians, as we learn from the French surgeons who witnessed the operation during the Eastern campaigns of Napoleon Bonaparte. We learn also from Prosper Alpinus that among the Egyptians small calculi were removed from the bladder by first inflating the urethra with air, and afterwards with a finger in the rectum pressing the stone into the neck of the bladder, from which it was drawn forward by stripping the penis.

In using the catheter the bladder is to be well distended with tepid water, after which the tube is introduced, when the sudden gush of water through its canal will probably carry the calculus into the eyes of the instrument. Mr. Bell, of Edinburgh, succeeded in this way in removing from the bladder of a patient one hundred and fifty small stones.

When the forceps of Cooper are employed, they are to be introduced, after dilatation of the urethra, into the bladder with the blades closed, and used as a sound or searcher. On touching the concretion the blades are to be separated, and by a dexterous movement made to embrace the stone, when, if not too large,—which may be determined by the index near the handle,—the surgeon may proceed cautiously to extract the foreign body. In this way Sir Astley Cooper, Brodie, and others succeeded in extracting calculous concretions. In France as early as 1561 a canula inclosing four blades was used for the same object. Hildanus modified this instrument by omitting one of the blades.

These forceps are admirably adapted for the extraction of calculi from the female bladder, as will be seen farther on.

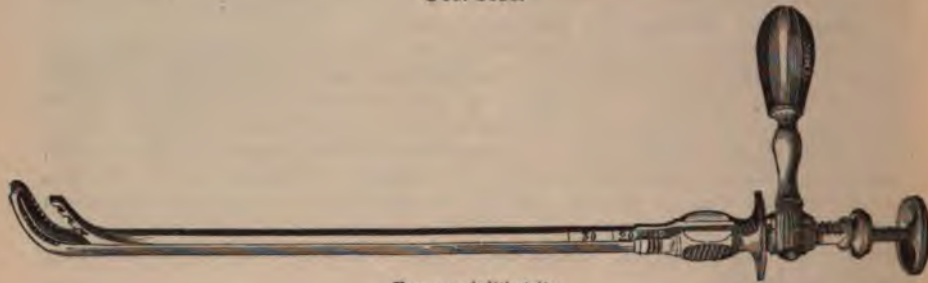
Lithotrity.

It is not a matter of surprise that surgeons, in view of the formidable character of lithotomy, the exceptional skill required for its proper execution, and the mortality which has attended its performance, should have given much thought to the subject of discovering some other and less fatal mode of removing calculi from the bladder. The first steps in this direction appear to have been taken by two Italians, Santorio and Ciucci,—the former in 1626, and the latter in 1670. In 1814, Graithuisen, a surgeon of Munich, Bavaria, brought to the notice of the profession a mode of dealing with vesical calculi by drilling or boring, and, after having in this way honey-combed the stone, crushing the pieces asunder. Of a similar nature was the operation of Elderton, of Scotland.

While the early labors of these men are entitled to much consideration as giving direction to surgical thought, it is to Civiale more than to any other individual that we are indebted for lithotrity. This French surgeon as early as 1817, when a medical student, was industriously occupied devising instruments to render the operation practicable. The first mechanism which he produced, commonly known as the *trilabe*, consisted of a central drill and three arms or branches with incurved extremities. The instrument was introduced into the bladder closed, after which the branches were expanded and made by a gentle manipulation to grasp the stone, when the latter was bored through in different places and then broken. With this lithotrite Civiale in 1824, before a committee appointed by the Academy of Medicine, operated on two patients with stone, with much success. The subject was also prosecuted by Amussat in 1822, and by Leroy d'Etiolles one year later. The instrument of Civiale, however, was clumsy, and not well adapted for accomplishing the object in view. In 1824, Mr. Weiss, of London, designed a lithotrite in which the blades, two in number, were placed at an angle with the shaft, so that the calculus could be seized and crushed between them by a screw acting on the movable blade. The invention of this instrument marked a very important period in the history of lithotrity, as it substituted crushing for boring or drilling. With a lithotrite in most particulars like the one of Weiss, in 1825 Mr. Hodgson first performed at the Birmingham Hospital the operation of crushing.

The manner of communicating the force to the stone after it has been grasped has also engaged the attention of surgeons. In 1832, Baron Heurteloup adopted the plan of fixing the handle of the instrument between the jaws of a vise conveniently placed by the bed of the patient, and by repeated blows with a hammer on the movable blade causing the stone to give way. He was followed by Costello, who communicated the power to the jaws of the lithotrite by a modification of the screw. Changes in the instrument were subsequently made by Mr. L'Estrange, of Dublin. It was in the

FIG. 1384.



Fergusson's lithotrite,

use of these last improvements that Sir Benjamin Brodie acquired his reputation in this branch of operative surgery.

Sir William Fergusson applied the crushing power by means of the rack and pinion (Fig. 1384), a modification of the lithotrite, which I believe he never abandoned. Another alteration was made by Mr. Oldham in the form of the female blade, which consisted in making it fenestrated.

The instrument was finally brought approximately to perfection by the conjoined labors of Civiale and the eminent surgical cutler of Paris, M. Charrière. (Fig. 1385.) This lithotrite consists of a male and a female blade

FIG. 1385.



Civiale and Charrière's lithotrite.

the former moved up and down without the action of a screw, simply by the hand grasping the pinion or wheel placed at the end of the handle, and this sliding movement can instantly be changed to the screw-motion by slipping into place a button on the side of the instrument. The female blade is concave, but not fenestrated, and its edges are beveled and project a little beyond those of the male blade, an arrangement by which the folds of the bladder are less likely to be pinched.

FIG. 1386.



Sir Henry Thompson's lithotrite.

The most complete lithotrite, however, in use at present is that of Sir Henry Thompson (Fig. 1386), the principal features of which are the cylin-

dricul handle and the convenient position of the button, by which the instrument can be thrown into or out of gear when in use.

There are other forms of lithotrite blades, as the fenestrated (Fig. 1387), the flat (Fig. 1388), and the wedge-shaped (Fig. 1389).



In the fenestrated lithotrite the female blade is slit, and the male blade having teeth passes into the former. Though a powerful instrument, it is a dangerous one, as the mucous membrane of the bladder may be seriously damaged by entering the fenestra and becoming lacerated by the male blade. The fragments also which result from its use have sharp edges or angles, which are liable to damage the bladder. The flat-bladed lithotrite is open to the same objection as the fenestrated in reference to the liability of the mucous fold of the bladder to be pinched.

CASES SUITED FOR LITHOTRITY.—In the selection of cases adapted for the operation of lithotry we must take into consideration the composition, number, and size of the calculi, and the age and peculiarities of the patient.

Stone.—Uric acid and phosphate stones, having usually a soft texture, are best suited for crushing, unless several large concretions are believed to exist or the size of the calculus is too great. When the latter exceeds in bulk the dimensions of a hulled walnut, it will be most prudent to decline the use of the lithotrite; and the same course should be adopted in cases of oxalate of lime calculi, even though not exceeding the size of a hickory-nut. Lithotomy in cases of this kind will be both wiser and safer.

PATIENTS.—With reference to the subjects of operation, children, who always do well when lithotomized, should be excluded from the category of cases adapted for crushing. The entire urinary tract requires to be sound in order to render the use of the lithotrite successful. Thus, stricture of the urethra will prove a bar to the operation unless the coarctation has been first thoroughly dilated; and so will an irritable, contracted, or highly-inflamed bladder, which refuses to retain a moderate amount of urine. This must not be construed as excluding crushing in cases of a chronically-inflamed bladder, as few persons suffering from stone of any kind escape this condition. A highly irritable urethra, one which habitually resents the passage of a sound, either by the urethral fever which follows its use, or by attacks of epididymitis, will be unfavorable to lithotry. Tumors, of whatever nature, malignant or benign, whether derived from the prostate or arising independently in the neck of the bladder, are incompatible with the use of the lithotrite.

The sacculated bladder is also unfavorable for crushing, as fragments of the stone when broken are liable to enter the pockets.

Extensive disease of the kidneys or ureters always contra-indicates the operation of crushing. Too much weight cannot be given to this maxim. I have seen three patients die within twenty-four hours after breaking a stone, from suppression of urine.

Atony or paralysis of the bladder does not preclude crushing, though more than ordinary care must be observed in the manipulations, as the diminished sensibility of the organ exposes it to injury without any complaint being made by the patient.

In females, when the stone cannot be extracted from the bladder through the dilated urethra, crushing is indicated.

TREATMENT PREPARATORY TO LITHOTRITY.—This consists in allaying any severe irritation of the bladder, such as belongs to what is commonly termed a "fit of stone," and which is often induced by the jolting, exposure, or irregularities of diet incident to travel. A few days' rest in the recumbent position, a warm flaxseed-meal poultice over the perineum, the genital organs, and the hypogastrium, a warm-water enema to dislodge any fecal accumulations in the lower bowel, followed by an opium suppository, and the free use of alkaline diluents, constitute the leading details of treatment, and rarely fail in the course of two or three days to subdue any unusual perturbation of the bladder. Even when no aggravation of vesical symptoms is present, I deem it a salutary practice not to operate on patients who are just off a journey until they have had the benefit of one or two days' rest. When the signs of unusual irritation have disappeared, the sound may be introduced into the bladder, with the twofold object of searching for the stone and determining the capacity and tolerance of the canal for instruments. It may be necessary in some instances, by the use of graduated bougies, to dilate the urethra, so as to admit with ease the lithotrite; though this is not often demanded. The external meatus, which is sometimes found unnaturally contracted, may require a preliminary treatment of this kind, and sometimes incision.

OPERATION.—Lithotritry is an operation which demands great tact, gentleness, precision, and delicacy of movement, with concentrated attention on the work in hand. Though it is neither so bold nor so brilliant in effect as the operation of lithotomy, I think the art of crushing safely a vesical calculus requires a much higher order of manual skill than is ordinarily displayed in lithotomy.

In adjusting the patient for lithotritry, he may be placed on a table covered with a folded comfortable, and with a low pillow under his head; or he may lie across the bed, with the hips resting on its edge, and the feet supported on a stool or chair, the limbs being somewhat drawn up and separated from each other. The room should be warm, and both the body and extremities well protected by sufficient covering, in order to avoid all occasion of chill. If the patient has not been able to retain his urine for an hour before the operation, three or four ounces of tepid water or thin flaxseed-tea should be injected into the bladder. The propriety of administering an anæsthetic must be determined by the sensibility of the patient, or by his ability to bear a certain amount of uneasiness or discomfort, seldom rising to severe pain.

If, however, the individual prefers to be unconscious to the entire proceeding, the anæsthetic need not be withheld.

The operator, standing on the side most convenient to himself, takes the lithotrite, previously warmed and well oiled, and, entering it horizontally into the urethra with one hand while the penis is held by the other, passes it steadily, almost by its own weight, along the canal, depressing slowly the handle of the instrument as the membranous portion of the urethra is approached, until the blades glide under the arch of the pubes and enter the bladder, the handle of the instrument being now between the thighs. Having reached the bladder, the next step is to discover and seize the stone.

Probably on entering the viscus the point of the lithotrite will come in contact with the calculus, which will be known by the sensation communicated to the hand. Raising now the handle of the lithotrite, and holding it after the manner illustrated in Fig. 1390, one hand grasping the cylinder, and the other the wheel at one end of the handle, which moves the male blade, the latter is drawn out some distance, and then pushed back, when most probably the stone will be caught between the jaws of the instrument. (Fig. 1391.)

If this is the case, the button on the handle is to be slid back, which converts the sliding into the screw movement; then, by turning the wheel, the concretion will be crushed into pieces as the blades are forced together.

This done, the button is to be slid forward. This releases the male blade,

which should now be drawn out and again closed, when one of the broken fragments may be caught and crushed, in the same manner as was done with the entire stone. This process may be repeated two or three times, when the jaws of the lithotrite are to be closed and the instrument withdrawn from the bladder.

It may happen that when the lithotrite is introduced into the bladder, and its blades are separated and closed, as above described, no calculus is caught.

FIG. 1390.



Manner of holding the lithotrite as its blades are about to be separated.

Then the handle of the instrument should be carried somewhat to one side, and the blades opened and closed as in the first instance. Failing again to catch the stone, the point should be directed towards the opposite side, and the movements of the blades be repeated. If still unsuccessful, the search

FIG. 1391.



Second position of holding the lithotrite; the stone caught between the blades, and raised before being crushed.

should next be made in the bas-fond of the bladder, or behind and below the prostate body. To accomplish this manœuvre, the handle of the lithotrite should be depressed, and the instrument turned half-way round, so that the jaws shall be reversed and directed downward. If in this position the blades are opened and closed, the stone will usually be caught, when the instrument must be turned to the first position, with the blades directed upward; then by turning the wheel the concretion will be crushed without endangering the walls of the bladder.

The object in these procedures is to seize and break the stone with as few movements of the lithotrite as possible. In most instances, if due gentleness is practiced, and the bladder not provoked to resistance, the calculus requires not to be sought for,—rather it falls into the jaws of the instrument.

Other methods of manipulating the lithotrite have been employed, and may, when the former fail, be adopted. That of Heurteloup, copied by Brodie, and at one time known as the English method, consists in introducing the lithotrite in the manner already described, and when well into the bladder elevating the handle so as to bring the convex surface of the blades in contact with its posterior wall behind the prostate body, and while the male blade is being drawn out and again pushed back, at the same time pressing the female blade towards the rectum, in order that the calculus may roll in between the jaws of the instrument. Should this not occur, the lithotrite,

still held in the *bas-fond*, may be tapped with the hand, first on one side and then anteriorly, the impulse from which reaching the bladder will tend to cause the stone to drop from its resting-place into the jaws expanded for its reception.

If still unsuccessful, the closed instrument may be turned very slightly to one or the other side, thus placing the blades in a position somewhat oblique to the antero-posterior axis of the body, when they may again be opened and closed with the hope of catching the concretion.

Civiale's plan of manipulation differs somewhat from that detailed. The lithotrite is carried well into the bladder, and should its curved extremity in passing onward touch the stone the operator moves a little either to the right or to the left, with a view to ascertain the position of the calculus. After this is recognized, the instrument should be carried slightly in the opposite direction from that occupied by the stone, and while pressing the female blade towards the rectum the male blade should be slowly withdrawn; after which the jaws of the lithotrite are to be inclined in the direction of the concretion, which will probably fall into the trap set for its reception.

Large calculi are almost invariably found near the neck of the bladder, immediately behind the prostate, and are usually touched by the lithotrite as it enters the organ. When this is the case, the stone is most certainly caught by pushing the female blade onward while the male blade is held fixedly in position. The jaws being now separated, let the instrument be withdrawn a trifle and turned slightly on its axis towards the stone, when by pressing homeward the male blade the calculus will be found to be caught.

It is proper to say that no single manipulation or manœuvre will meet every case of vesical calculus, and consequently the surgeon must be familiar with all. In my own operations I follow very much the order in which the different methods have been described, though in a very large proportion of cases I find the one first noticed to answer the object in view. A calculus, on account of its small size and its position close to the neck of the bladder, may successfully elude the grasp of the lithotrite. Under these circumstances the hips of the patient will require to be raised, by placing a cushion underneath the pelvis, so as to roll the stone back, and thus not only enlarge the field of exploration but place the concretion in a more accessible location. The same position will often be necessary when searching for fragments in secondary operations.

Cautions.—There are several injunctions which cannot be too strongly observed in performing lithotrity. First, no jerking, uncertain, or rapid movement of the instrument is allowable while it is being manipulated in the bladder; secondly, the lithotrite should be held firmly in one position while the male blade is being moved, and at a point sufficiently removed from the centre of the bladder to prevent the aforementioned blade from striking the neck of the organ, an accident which is always to be deprecated; thirdly, when a stone is once caught the instrument should be moved a little in different directions before applying the crushing power, in order to ascertain that no portion of the bladder is included in its grasp.

What amount of work it is proper to do in the bladder at a single sitting is a question not easily answered. The rule has been with many operators after breaking the stone to crush two or three fragments, and with this to be content. There is, however, a growing tendency to carry this process of reducing the calculus to a much greater extent, and even, as I shall presently describe, to complete the entire work at a single sitting, in the belief that the presence of fragments is more dangerous to the bladder than prolonged instrumentation. This was formerly thought by not a few surgeons, myself among them, to be rather bold surgery. It was contrary to old usages; and, while not by any means protesting against the innovation, I was unwilling to speak dogmatically on the subject until I had cautiously tested the method, and until a sufficient number of facts or observations had been accumulated to justify a sound deduction, or on which to found a safe

rule of practice. As to the length of time during which the lithotrite may properly be retained in the bladder, much will depend on the tact of the operator, and on the previously ascertained tractability of the urinary passages under the use of instruments, as the sound or the bougie. A surgeon who has been trained by long experience in the use of the lithotrite may continue harmlessly the crushing much longer than a less experienced operator. The latter would probably do more harm to the bladder in a minute than the former would inflict in half an hour. The amount of instrumentation, therefore, which may be proper in the hands of an experienced lithotritrist may be highly improper in those who enjoy fewer opportunities for executing such operations.

According to the old plan, if a patient, after being sounded, suffered from chills, urethral fever, and vesical irritation, it was advised that the first crushing should be brief, and limited to breaking the stone, not to pulverizing the fragments, by which the temper of the bladder could be tested. It was directed that the same course should be adopted in cases where it was necessary to turn the end of the blades of the lithotrite towards the trigonum vesicæ in order to catch the concretion, as the walls of the bladder under these circumstances were more likely to sustain injury than when the stone was more favorably located. The same rule applied to cases of old men with great enlargement of the prostate body.

When the bladder manifested no unusual irritability and the calculus was soft and did not exceed much in size a hickory-nut, it was disposed of at a single sitting. If, on the contrary, the stone was of greater magnitude and of very hard consistence, and the bladder unwilling to retain the urine, the water being ejected, it was considered unsafe to persevere in the pulverization of the fragments beyond eight or ten minutes. There was an advantage in always using two instruments,—first a large and strong one adapted to breaking the calculus, and afterwards a more delicately constructed one to reduce the fragments. That the bladder might be at rest, the water was drawn with a soft catheter, thus preventing the immediate passing of fragments and the consequent irritation. After this, the patient was placed in bed, covered up warm, and a suppository consisting of two grains of opium with half a grain of belladonna introduced into the rectum, followed by a warm flaxseed poultice applied over the hypogastrium, the genitals, and the perineum. The diet for the first three days was restricted to milk and bread; after which, if no unusual symptoms arose, a moderate amount of solid food was allowed.

During the first twenty-four hours the patient was not allowed to rise in order to pass the urine. By thus refraining from urination the neck of the bladder escaped to some extent the irritation of sharp fragments which in the perpendicular posture would have fallen against it, and time was allowed for some smoothing off of angularities and edges. After this precautionary period was past he was allowed to empty the bladder in the standing posture, and was directed to drink freely of some diluent, such as barley-water, which should tend to favor the expulsion of the detritus. In order to collect the debris, the urine was passed through a piece of fine tarlatan stretched over the urinal, which served to separate it from the water. If no complications followed, the operation was repeated in from three to eight days. The rule, equally applicable to both the first and the second crushing, was always to confine the operation to that part of the bladder where the stone or its fragments were first found, without shifting the instrument from place to place, as the debris manifests a strong disposition to keep together.

Management of the debris.—There were two plans for disposing of the fragments produced by crushing. By the one their discharge was left to natural processes,—that is, the voluntary efforts of micturition; by the other they were extracted at once with an evacuating apparatus.

The advocates of the first plan taught that by allowing the coarser par-

ticles of the débris to remain for twenty-four hours or longer in the bladder their angularities would be worn off, and thus cause less injury to the bladder

FIG. 1392.



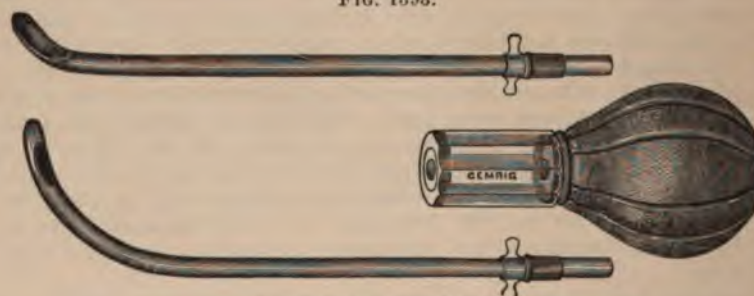
Professor Bigelow's lithotrite.

and the urethra during their expulsion. On the other hand, those who advocated the immediate removal of the fragments believed that the sooner they were expelled from the bladder the better, as their sharp points coming in contact with the mucous membrane of the bladder would do more harm than would their forcible expulsion. Such was the opinion of Sir William Fergusson, and, with certain limitations, of Sir Henry Thompson.

Sir William Fergusson effected the extraction of the fragments by the use of a small scoop. A better apparatus, however, is that of Clover. This consists of an elastic bottle with a glass reservoir attached, into which a large catheter,

with an ample concave eye, is fitted. The catheter is first introduced into the bladder and the urine drawn off. The bottle, being now filled with warm water, is connected with the tube, and alternately compressed and relaxed; the fluid is forced into the bladder, and returns as the bulb expands, bearing on the reflux current a quantity of débris, which is deposited in the glass cylinder. (Fig. 1393.) Interruption or stoppage of the stream will

FIG. 1393.



Evacuating apparatus of Clover.

indicate the entrance into the catheter of a fragment which is too large to pass through, and which must be dislodged or driven back into the bladder by forcibly impelling the liquid in the reversed direction.

Dittel's apparatus.—Another evacuating appliance is that of Professor Dittel, which consists of a large-sized catheter to which is fitted an attachment having three limbs,—one the catheter limb, a second an outflow limb, and the third a syringe limb. At the place where these three limbs come together there is a valve-arrangement similar to that used in the stomach-pump. To the outflow branch a flexible rubber hose, several feet in length, is attached, the free end resting in a vessel on the floor some distance below the patient. As the water is thrown through the syringe branch into the bladder, it returns through the outflow limb into the hose, the latter constituting the long limb of the siphon.

Colin's evacuator, rarely, if ever, seen in this country, is formed of the following parts: a catheter of large calibre and short curve, a glass cylinder with an opening before and behind, and an air-pump, the piston of which is moved by means of a toothed wheel acting on a dentated bar. When employed for removing the detritus of a stone, a few ounces of warm water are

injected into the bladder through a catheter, the end of which is afterwards fitted into one of the openings in the glass cylinder, while the end of the suction-pump is introduced into the other, and the contents of the bladder are drawn out by working the piston.

In 1878, Bigelow, of Boston, introduced an operation which he termed *litholapaxy*, by which large and hard stones are broken into fragments and

FIG. 1394.



Bigelow's evacuator. The coiled tube is used to replenish the bulb when required.

removed at a single sitting, limited only by the time necessary for the comminution and extraction. The lithotrite used for the purpose is larger and more powerful than the instrument formerly in use. The floor of the female blade is somewhat elevated, and the male blade, in addition to a central septum at the heel, has lateral triangular notches. The female blade is also furnished with a slot, which receives the spur at the head of the male blade. (Fig. 1392.) After breaking the stone a number of times, a smaller lithotrite is employed for the further reduction of the fragments, and the débris is removed by a large catheter attached to an aspirating bottle. (Fig. 1394.) The evacuator consists of a large elastic bulb, with a glass bottle at one end, which can be detached, and with two stop-cocks, one for filling the bulb and the other for making the articulation with the catheter. The evacuating catheters are either straight or are slightly curved near the vesical extremity, and are of large size (Nos. 28 to 30 of the French scale). In using this apparatus, the bulb is charged with warm water, and, after introducing into the bladder one of the catheters and establishing a connection between the two, the evacuating-tube is pressed firmly against the bas-fond of the bladder, so as to invite the fragments towards the open orifice at its end; the bulb is then compressed, and a stream of water is forced into the organ. On removing the pressure, the expansion of the bulb sets up a reflux

current, which carries with it the broken fragments of stone and deposits them in the glass bottle. This is to be repeated until all débris has been extracted from the bladder. If during this operation the tube becomes obstructed by a fragment too large for the lumen of its canal,—an occurrence which may readily be detected by an unequal and slow expansion of the gum bottle,—it can be cleared by waiting until the latter has become in a great measure distended and then forcibly compressing the bulb and driving back the obstruction before the column of water.

In forcing the stream into the bladder, the bulb of the evacuator should be subjected to quick, partial, and not too rapid compressions, and the liquid used should be either warm water which has been previously boiled, or, better, a saturated solution of boracic acid.

Rapid lithotripsy, completed at a single sitting, experience has proved to possess advantages over all former methods, and is the accepted and established plan of dealing with calculi other than those of oxalate of lime.

Complications or sequences.—In cases where the bladder is in a state of atony or paralysis, and consequently unable by its own contractility to expel the débris incident to crushing a calculus, artificial evacuation of the fragments will be demanded. Generally a bladder in this condition, from defective sensibility, is quite tolerant to protracted instrumentation, whether of crushing or of evacuating.

Again, in cystitis following the use of the lithotrite, it is highly important that any fragments present should be removed from the bladder at the earliest moment, in order that the chief source of irritation may be got rid of; and for this purpose the crushing, if required, should be renewed and the evacuations effected by the Bigelow apparatus. We are indebted to Sir Henry Thompson for this practice, the soundness of which has been proved by the experience of other operators. It is desirable under these circumstances to bring the patient under the influence of an anæsthetic before performing the operation.

Even though no fragments remain in the bladder, a certain degree of cystitis occasionally follows the use of the lithotrite, as will be indicated by frequent and painful urination continuing after the operation. These are cases which demand particular attention to the state of the bladder, to see that no residual urine is retained; and this can be determined only by the use of the catheter. If after urination a soft instrument is passed, and a quantity of water, even though it is small, is drawn away, it will show that the organ does not fully relieve itself, and will also indicate the necessity for repeating the catheterization at least once daily. The effect of this will be not only to prolong the periods of micturition, but also to remove the cystitis, which if allowed to continue would cause such deposits (phosphatic) as would lead to the formation of another stone.

Traumatic, or urethral and vesical fever.—Not unfrequently, three or four hours after lithotripsy, the patient is attacked by a rigor lasting from eighteen to twenty minutes, and followed by a high fever, with an elevated temperature, flushed face, dry, hot skin, and urgent thirst, with pain in the back and headache. These symptoms, after one or two hours, pass off with sweating, and the patient may experience no inconvenience other than a sense of exhaustion. This paroxysm of surgical fever may, in most instances, be safely left to the salutary effects of nature. Little is required beyond placing some additional coverings on the body, keeping bottles of hot water to the feet and along the spine, and allowing the use of some hot lemonade. When reaction sets in, a portion of the bed-covering will require to be removed, and the warm drinks replaced by cold water or effervescing drinks. The diet must at first be of a non-stimulating nature, as milk, toast-water, or barley-water, and should be increased both in quantity and in strength after the febrile perturbation has passed.

Hæmorrhage, though not very uncommon after lithotripsy, rarely assumes sufficient importance to demand special notice. Should it do so, however, it

must be managed according to the principles already explained under the head of vesical hemorrhage. In one instance Mr. Key, after crushing a calculus, was, in consequence of the alarming nature of the bleeding, compelled to perform lithotomy.

Orchitis.—Swelling of the testicle occasionally follows the operation of crushing a stone, excited either by irritation reflected from the bladder and urethra, or, as occasionally happens, from a portion of the calculus lodging in the latter canal. Rest in the recumbent position, elevation of the scrotum and the application of a lotion of lead-water and laudanum, a mild laxative, and at night a sufficient amount of some anodyne to allay pain and to procure rest, constitute the proper treatment. It is best to abstain from repeating the operation until the swelling and undue sensibility of the testis have disappeared. If, however, the inflammatory state of the testicle is associated with an attack of cystitis, and the bladder has not been cleared of its detritus, neither the lithotrite nor the aspirator should be withheld.

Suppression of urine following lithotrity is always an alarming occurrence. It may ensue either from shock or from some pre-existing renal inflammation or degeneration. The remedies are warm poultices around the loins, containing the leaves of digitalis, and the free use of alkaline drinks, with quinine and milk-punch.

Pyæmia, especially in old subjects who have long suffered from stone, and whose health has been broken by chronic cystitis, is a not uncommon result of lithotrity, and requires for its treatment quinine, iron, stimulants, and concentrated liquid nourishment.

Perforation of the bladder has happened in a few instances: unless occurring in a bladder greatly thinned and softened from disease, such an event argues a rude and unskillful use of instruments. An accident of this nature would give rise to collapse, vomiting, abdominal distention and tenderness, and the absence of urine from the bladder, with perhaps the escape of blood when a catheter is introduced into that viscus.

The treatment should be the same as that laid down under the head of rupture of the bladder.

Impaction of fragments in the neck of the bladder or in the urethra is one of the common sequels of "crushing." The fact of such an impaction having taken place will be sufficiently indicated by the obstruction offered to the outflow of the urine, the water escaping either in drops or in several small contorted streams. Extraction by the forceps, or, when this is not feasible, pushing the body back again into the bladder by a catheter or a bougie, as already described when treating of foreign bodies in the urethra, is the proper course to pursue.

Derangement or fracture of the blades of the lithotrite is an exceedingly embarrassing accident. I have known the jaws of the instrument, from some defect in the button which fixes or releases the male blade, obstinately to refuse to close. In one instance the evil incident to the removal of an instrument in this condition resulted in the death of the patient. Should the skill of the surgeon not be sufficient to overcome this derangement in the mechanism of the lithotrite, it must be allowed to remain in the bladder until the assistance of a surgical cutler can be obtained. Should a jaw break off, its extraction by median lithotomy would be required. In addition to the above-named sequels of lithotrity there may follow prostatitis, peritonitis, and pelvic cellulitis, all of which are to be managed on the general principles which have already been discussed under their several heads.

RESULTS.—What are the results of lithotrity? This is a question of no small importance. Its answer embraces both the subject of mortality and the tendency to relapse. The success of the operation varies according to the skill of the operator and the method which he adopts. Sir Henry Thompson reports 422 cases of lithotrity performed by himself, with 32 deaths,—that is, 1 in 13, or a mortality of 7.58 per cent. Sir Benjamin Brodie's cases of this operation amount to 115, with 9 deaths, or a mortality of 7.74 per

cent. Sir William Fergusson in 109 lithotrities had 12 deaths, or 11 per cent. Keith in 122 cases had 8 deaths, or 6.55 per cent. Mr. Crichton in the same number of operations as Keith—122—had precisely the same mortality, that is, 8 deaths, or 6.55 per cent. Leroy in 116 lithotrities had 11 deaths, or a mortality of 9.48 per cent. Ivanchich in 100 cases lost 13, a mortality of 13 per cent.; and Porter in 133 cases had 24 deaths, or 18 per cent. The aggregate of all these operations amounts to 1239, with 117 deaths, or a death-rate of 9.42.

In the Pennsylvania Hospital the recorded operations of lithotrity amount to 14, with 2 deaths, or 14.28 per cent.*

Gross in a collection of 1470 lithotrities found 159 deaths, or 10.81 per cent.

Any comparison instituted between lithotrity and lithotomy with a view to determine the comparative mortality of the two operations would lead to very erroneous conclusions adverse to lithotomy, simply because the cases which are subjected to crushing are all selected,—they must be of a certain character as to age, organic soundness, size, and composition of the stone,—while in lithotomy the cases are taken indiscriminately, the unfavorable with the favorable. There is one class of calculous patients, namely, children, which until lately were excluded from the domain of lithotrity, but which is eminently well adapted to lithotomy; and, from the numerical superiority of this class, a very large proportion of all cases of lithotomy are performed on children, and with almost uniform success. It is in adults that lithotrity makes its greatest conquests, and it is among adults that lithotomy sustain so many defeats. Sir Henry Thompson has analyzed 723 cases of lithotomy performed on the above class of persons, of which number 1 in 4.82 prove fatal; whereas in a like number of lithotrities in the same class, taken from the practice of English and American surgeons, the deaths will not exceed 1 in 14 patients.

The tendency to relapse is unquestionably much greater after lithotrity than after lithotomy. This results from that last fragment which in lithotrity is liable to elude detection, and which becomes the nucleus for another stone. In the cases of calculus treated by Thompson by crushing after the old plan, this occurred as often as once in every twelve cases, and in the experience of Civiale once in every ten cases; while, as nearly as can be determined from accessible data, a recurrence of stone after lithotomy does not occur oftener than once in every fifty-seven cases. Of my own cases of lithotomy—certainly over one hundred—I cannot recall more than three relapses. Of course, others may have occurred which were not reported.

Or we may compare the operations of crushing and cutting as practiced by the same surgeon. Sir Henry Thompson reports having performed 422 lithotrities, with 32 deaths, or 1 in 13 cases, and 78 lithotomies, with 29 deaths, or 1 in 2½ cases. Very similar results appear to have been attained by Sir William Fergusson. Of the 271 cases of stone which came under the care of this eminent surgeon (217 of which were adults), 109 were treated by lithotrity, with 12 deaths, while of 110 subjected to lithotomy 32 died.

Of 696 cases of lithotrity performed by the Bigelow method, which I have collected from different statistical sources, the records make mention of only 31 deaths. Sir Henry Thompson's mortality under the same method, as compared with that under the old plan, has been reduced about one-half. Professor Andrews reports 40 cases of lithotrity with 1 death.†

Lithotomy.

Lithotomy, or the extraction of stone by cutting, is one of the most impressive operations in surgery. It demands not only the utmost precision

* All the above-quoted lithotrities were done under the old plan, and therefore do not fairly represent the results of the modern method, as will be seen below.

† Journal of the American Medical Association, June 15, 1889.

re for its execution, but also an unusual degree of self-possession and boldness of purpose. The pupils of Hippocrates were compelled by their master under a solemn oath to promise that they would never perform the cutting operation for stone. Lithotomy at this time was in the hands of men who possessed not a single qualification for its execution except fearlessness, and so great was the anatomical ignorance of these itinerants that the mortality following the procedure was frightful.

Four different plans were originally employed for the extraction of stone. The first is often termed the method of Celsus, from its having received the sanction of that distinguished physician, though the operation has been known for at least two thousand years. This plan is often described as lithotomy by the *apparatus minor*. The second method is the Marian, or that by the *apparatus magnus*, as performed by Marianus Sanctus. The third method is the *sectio hypogastrica*, or that by the *apparatus altus*, practiced originally by Peter Franco, in which the stone was removed through the abdominal walls above the pubes, at present better known as supra-pubic lithotomy; and the fourth, or most recent plan, is the lateral section of the perineum, devised by a French monk, Frère Jacques, and introduced to the profession during the latter part of the seventeenth century.

The Celsean method, more properly that by the *apparatus minor*, received its latter name from the very few instruments required for its performance. The patient, when an adult, had the hands and feet secured together and held by strong assistants; if a child, he was supported on the knees of an assistant, who, while seated on a chair, passed his hands beneath the limbs and grasped with a firm grip the wrists of the little one. The operator, having anointed the forefinger of the left hand with oil, introduced it into the rectum of the patient and carried it forward towards the prostate, while with the right hand pressed strongly above the pubes he endeavored to touch the stone through the walls of the bladder, on doing which it was pushed over to the left side of the viscus, whence it was dragged forward by the finger in the rectum, so as to form a visible prominence on the left side of the perineum. It was then cut down upon by a bistoury, the structures being divided regularly inward. As soon as the opening was made into the bladder, the calculus was thrust out through the wound by the finger which held it against the perineum; or, if too voluminous to be extracted in this manner, it was drawn out by a hook. This operation, from the manner in which it was done, was not improperly termed "*cutting on the gripe*."

The method by the *apparatus major*, believed to have been first devised by Franciscus de Romani, an Italian physician of celebrity, who lived at Cremona, was subsequently improved by one of his pupils, Marianus Sanctus, and hence has been called the *Marian method*. A steel catheter, having a groove in its convex surface, was passed through the urethra into the bladder, and its vesical extremity turned towards the left side of the perineum, where it was held by an assistant, while the surgeon made an incision (in the middle of the perineum, corresponding to the raphe between the scrotum and the anus) with a broad, lancet-shaped scalpel, part of the knife being wrapped with a piece of muslin. The tissues were divided until the catheter was reached in the membranous portion of the urethra. The latter being next opened, and the groove of the staff exposed, the incision was continued as far back as the prostate gland, after which a male conductor was fitted to the groove and carried onward into the bladder, when the catheter was withdrawn. A female conductor was next passed into the viscus, and the neck of the bladder dilated by separating the handles of the two instruments. As soon as the dilatation was carried to a sufficient extent, a pair of forceps was introduced into the bladder between the two conductors, and the stone extracted. Other operators, instead of employing the male and female conductors, passed along the groove of the catheter a gorget, which as it entered the bladder not only stretched the neck of the organ, but also acted as a guide for the introduction of the stone forceps. Originally, the neck of the

bladder in this operation was divided instead of being dilated. The extraction of the calculus was also effected in many instances by a spoon-shaped scoop and a finger.

Hypogastric operation.—This operation has been variously named,—as that by the *apparatus altus*, the high operation, the hypogastric section, the *methodus Franconica*, and more recently the supra-pubic. This method is attributed to a French surgeon named Peter Franco. His first operation of this nature was done on a patient at Lausanne, Switzerland, in 1560, not of choice, but from an inability to extract the stone through the perineum in consequence of its great magnitude. The operation fell into disuse, but was revived by Douglas in England, and also advocated in France, in 1727, by Morand, from which time to the present it has been alternately praised and condemned. The bladder is exposed in this operation by cutting through the linea alba immediately above the pubes and opening the fundus of the organ anterior to its peritoneal investment.

Lateral lithotomy, which at present is so generally practiced, is supposed to have been devised by Peter Franco, about the middle of the sixteenth century. In the latter part of the seventeenth century, or about the year 1697, an obscure monk, named Frère Jacques, created a great sensation on the continent of Europe as a lithotomist. This man came to Paris in a state of absolute poverty, announcing to the public that his object was to instruct the French surgeons in a new method of cutting for stone. His first application was made to the physicians and surgeons of the king, to be allowed to operate on a patient suffering from calculus, at the same time backing his application by the certificates of many persons who were represented as having been cured under his hands. From the entire absence of all mercenary considerations on the part of this monk, who, it appeared, received no compensation beyond what was necessary to keep in repair the instruments used in the operation, and from the novelty of the whole affair, Frère Jacques was permitted to demonstrate his method on the cadaver properly prepared, before many of the distinguished surgeons of Paris. The body was secured in the usual lithotomy position, and a catheter introduced into the bladder, with which he made the perineum somewhat prominent. A knife, somewhat longer than an ordinary bistoury, was next entered between the anus and the tuberosity of the ischium on the left side of the perineum, and the parts divided upward until, guided by the catheter, the neck of the bladder was opened. Then, passing a finger through the wound into the bladder, and finding the position of the improvised calculus, he first passed an instrument like a spoon or a scoop, which served as a guide for the forceps, conducted them readily into the organ, and quickly seized and extracted a large stone. Notwithstanding that the cadaver was afterwards carefully examined by the physicians and surgeons then present, and the incisions found to have passed through the triangle formed by the accelerator urinæ, the erector penis, and the transverse perineal muscles without inflicting any injury either upon these structures or upon the blood-vessels, and that the neck of the bladder had been properly opened, these gentlemen were unwilling to allow this itinerant lithotomist to operate on the living subject. Undeterred by this refusal, the monk presented his application and testimonials to the king's physicians and surgeons residing at Fontainebleau, praying that he might be allowed to operate on a patient whom he had found at that place suffering from stone. The request was granted, and the operation executed, it is said, with the same dexterity as had been exhibited on the cadaver in Paris. The effect of all this was, in the course of the following year, the procuring of a license from the king, on the strength of which he returned to Paris and cut a large number of patients afflicted with calculus. By this time so notorious had Jacques become that on the occasion of his operations the crowd which attended was so large that it was found necessary to detail a guard of soldiers to preserve the required order. When the results of these operations were ascertained, it

was found that many of the patients died, and that those who escaped with their lives were left with fistula and other serious sequels. In some the bladder was entirely severed from the urethra, and in others the rectum was opened,—all going to show that Jacques was utterly devoid of anatomical knowledge. He never employed any treatment either before or after his operations, and showed his ignorance, rashness, and inhumanity, when desired by his patients to attend to their wounds, by saying that it was sufficient for him to have extracted the stone: it was God's work to cure them. Notwithstanding his recklessness, the operations of Jacques were instrumental in attracting the attention of learned surgeons to the method employed, as one which, in the hands of men well instructed in the surgical anatomy of the perineum, and with proper instruments, might prove of the utmost value. We find that Maréchal in France, and Rau in Holland, by substituting for the hollow tube of Jacques a grooved catheter, made a valuable improvement. They were in the habit of making their incisions on one side of the perineum, and extracting stones with marked success. It is to an English surgeon, however, that we are indebted for the perfection of lateral lithotomy. Up to the time of Cheselden most operations for stone were performed either by the Marian or by the supra-pubic method. This surgeon, having heard of the plan employed by Frère Jacques and by Rau, carefully improved the instruments and adopted such other measures as were necessary for reaching the bladder with safety, finally systematizing and perfecting the operation now generally known as lateral lithotomy. So great was the success of Cheselden in this department of surgery that Morand was sent to London from Paris to witness his operations, and after his return made so favorable a report to the French Academy that the method of the distinguished surgeon of St. Thomas's Hospital was generally adopted. Perhaps no man since the days of Cheselden, with a single exception, Sir Henry Thompson, has attained an equal success. Of 213 patients whom he cut, of all ages, only 10 died. Sir Henry Thompson in 51 lithotomies done on elderly adults lost not a single case.

In addition to the operations already named, there are the *bilateral*, introduced by the celebrated Dupuytren in 1816; the *median*, inaccurately spoken of as a revival of the old Marian plan, and suggested by Manzoni, of Verona, Italy, in 1808, in 1825 patronized in England by Mr. Allarton, and in this country practiced to some extent by the late Dr. Walters, of Pittsburg; the *medio-bilateral*, advocated by Civiale; and the *recto-vesical*, devised by Sanson in 1816, all of which will be described in their proper order.

PREPARATION OF THE PATIENT.—Whatever operation may be determined on, it is highly important that the subject undergo some preparatory treatment. The first question to be decided is the fitness of the individual for any operation. The fact that the health of a patient laboring under calculus has in consequence of long-continued vesical irritation been seriously impaired is no bar to an operation, provided there is no evidence of organic disease of internal organs; on the contrary, such persons when relieved from the local irritation often recover very rapidly after lithotomy. Very different, however, is it with those who suffer from disease of the kidneys, dilated ureters, pulmonary consumption, and advanced structural alteration of the heart. Under these circumstances it is best to decline an operation altogether, as being attended with too great risk to life, and to dictate a course of treatment best adapted to the condition present. Again, the patient may be far advanced in life, and the stone one of great magnitude, when it is desirable that no operation shall be performed, the surgeon contenting himself with the use of those remedies which are calculated to mitigate the evils of the situation. Rest, alkaline or acid diluents (as the constitution of the water may suggest), a carefully-regulated diet, and an occasional evening suppository of opium, will not unfrequently secure such relief that life will not be materially, if at all, shortened. When the general health of the patient is sound, little more is required than three or four days of absolute

rest, some laxative medicine, and a somewhat restricted diet (using meat only once a day during the preparatory period), and, if much disturbed at night from bladder-irritation, the introduction into the bowels at bedtime of a suppository of opium and extract of hyoscyamin. On the evening preceding the day of operation the bowels must be cleaned out by a dose of Rochelle salt or castor oil, and after the action of the medicine an anodyne administered, either of morphia, opium, or deodorized tincture of opium.

Lateral Lithotomy.

In lateral lithotomy the division of the tissues is made on the left side of the perineum, extending inward through the prostate gland and the neck of the bladder.

Surgical anatomy.—A brief description of the surgical anatomy of the parts concerned in lateral lithotomy will contribute to the proper understanding of the subject.

The perineum, from being a mere fissure when the limbs are together, becomes an ample space when the legs and thighs are flexed and strongly abducted. It is equally divided by a dense line, the raphé, which extends from the scrotum to the anus. When the skin and superficial fascia are turned aside, a layer of adipose tissue is seen to fill up the fossæ—ischio-rectal—which exist between the sides of the rectum and the tuberosities of the ischium, and through which run branches of the inferior hemorrhoidal arteries, veins, and nerves.

If this mass of fat is removed from the ischio-rectal fossæ, the latter cavities will be found to be lined on all sides by fasciæ,—on the outside by the obturator, on the inside by the levator ani, and in front by the middle perineal fascia. The last-named fascia covers in the corpora cavernosa and corpus spongiosum of the penis, is attached laterally to the rami of the ischium and pubes, and posteriorly passes round the transverse perineal muscles and dips inward to become continuous with the deep perineal fascia or the triangular ligament. It is this deep prolongation of the fascia which separates that portion of the outlet of the pelvis nearest to the rectum from that part which contains the penis and urethra: hence the division of the perineum into urethral and anal. If this middle perineal fascia is divided vertically along the middle of the corpus spongiosum and transversely towards the ischium, and is turned off from the subjacent structures, there will be exposed anteriorly the accelerator urinæ muscles covering the bulb of the corpus spongiosum, the erector penis on each side overlying the crura of the corpora cavernosa, and, running across the perineum, the transverse perineal muscles. The last-named muscles, together with the accelerator and the sphincter ani, converge to form the *perineal centre*. The relations of the accelerator urinæ, erector penis, and transversus perinæi muscles are such that a triangular space is formed lying between the penis and the ascending ramus of the ischium; at the bottom of this lies the triangular ligament, a membrane consisting of two layers placed beneath the pubic arch, and between which are situated the membranous portion of the urethra, the compressor urethræ muscles, the glands of Cowper, and the artery of the bulb, the latter being near the apex of the muscular triangle just referred to. This artery is a branch of the internal pudic, which runs along the inner surface of the ramus ischii near its inner border and covered in by the obturator fascia. Immediately behind the deep or posterior leaf of the triangular ligament are the prostate body and the neck of the bladder. Fig. 1395 will serve to illustrate the above description of the male perineum.

Parts divided.—The structures divided in lateral lithotomy are the skin, superficial fascia, lower or external hemorrhoidal vessels and nerves, the posterior fibres of the accelerator urinæ and transversus perinæi muscles with the middle perineal fascia, transverse perineal vessels, and often also the superficial perineal vessels and nerves, a few of the anterior fibres of the

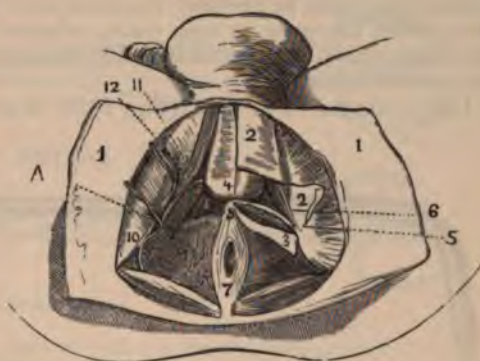
levator ani and compressor urethrae muscles, the membranous and prostatic portions of the urethra, and the prostate body.

OPERATION.—For the operation of lithotomy there is required a narrow, strong table, four or five feet in length, and covered with two or three thicknesses of a comfortable or blanket, the lower portion of which should be covered with a piece of rubber or of oil-cloth, and over this a folded sheet, both of which should hang some distance down over the lower end of the table, so as to conduct the blood and other discharges into a bucket properly placed for their reception. One or two pillows should be provided on which to rest the head and shoulders of the patient, without raising them too much, so as to create a *bend* at the waist, and the arrangement of the table will be complete.

Before the introduction of anæsthetics into surgery it was the invariable custom to fasten the hands and feet of the patient together by laces or bands. In America the limbs are secured by rollers, the initial ends being sewed into the form of loops, which are slipped over the wrists; after which the patient is made to grasp his feet in such a manner that, while the fingers rest across the soles, the thumbs are applied to the instep, and then the two are bound together by figure-of-eight turns made with the rest of the roller. There are many surgeons who still adhere to this custom of binding, notwithstanding the use of anæsthetics. For myself, I never employ any restraint of the kind.

The fore-part of the day is always to be preferred for the operation, as in the event of hemorrhage or other complications the surgeon will have the advantage of a satisfactory light in searching for vessels or rendering whatever assistance may be demanded. The patient should take a very light breakfast on the morning of the operation, simply a cup of coffee or a glass of milk with an egg, in order that he may suffer as little as possible from the sickness which so often follows the use of the anæsthetic. The rectum should be examined, and if found to contain any faeces it will be necessary to secure their removal by an enema of a little soap and water, administered about two hours before the cutting. The safety of the bowel is very greatly enhanced by this precaution. The hair must also be shaven from the perineum. Before proceeding to the operation, the surgeon should never neglect to reassure himself of the existence of the calculus, by repeating the test of sounding; and if unsuccessful in detecting the stone at this time he will not be justifiable in cutting his patient, even though he may have previously recognized the physical signs of its presence. The sound is a steel instrument, and should have one of two curves (Fig. 1376), which are sufficient to meet almost every form of the bladder. Some go so far as to insist that the *clink*, or sound of contact between the stone and the entering instrument, must be demonstrated to at least one other person besides the operator before extraction is attempted. But, if the surgeon has a practical familiarity with the subject of lithotomy, I would not insist on any such prerequisite. The existence of the calculus being placed beyond all peradventure, the patient must be brought well down, so that his breech will pro-

FIG. 1395.



Dissection of the male perineum: 1, skin, superficial fascia; 2, middle perineal fascia; 3, middle perineal fascia turned off the transverse perineal muscle; 4, accelerator urinae; 5, transverse perineal muscle and artery; 6, erector penis; 7, sphincter ani; 8, perineal centre; 9, ischio-rectal fossa; 10, internal pudic artery and branches; 11, Cowper's gland resting on deep fascia or triangular ligament; 12, artery of bulb. A, line of incision in lateral operation where it enters the membranous urethra.

ject over the lower end of the table. If the urine has been retained for an hour before the operation, there will be no necessity for injecting the bladder; if not, three or four ounces of lukewarm water or of thin flaxseed-tea may be injected into the bladder after etherization. In children, when no voluntary effort is made to hold the water, the practice of tying a piece of tape around the penis to prevent the escape of the urine is sometimes adopted. It is better, however, in such cases, to inject the bladder after the anæsthetic has taken effect. Any considerable distention of the organ with fluid is entirely unnecessary.

INSTRUMENTS.—The staff (Fig. 1396) is constructed of steel, and is about

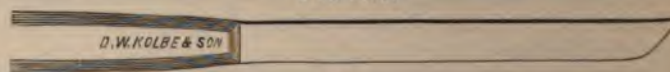
FIG. 1396.



Lithotomy staff.

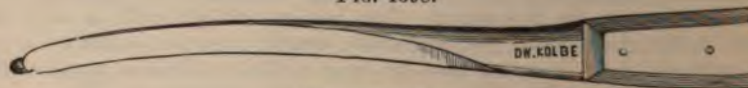
ten inches in length, having a handle with a rough surface, in order that it may be the more fixedly held. The groove is placed in the middle of the instrument. It should have a somewhat triangular shape, and extend from the middle of the staff to near its vesical extremity, which is usually well rounded or blunt. The curve of the instrument is important. It should commence rather abruptly, and be prolonged forward, with a very slight inclination upward. Two knives should be on hand. Different operators have their partialities in regard to shape. The one I employ is about six and a half inches in length, the blade making three inches of the whole, and its extremity being rather broad than sharp-pointed. (Fig. 1397.) The

FIG. 1397.



Knife.

FIG. 1398.



Blunt-pointed bistoury.

edge must be keen. A blunt-pointed bistoury (Fig. 1398) will prove useful should it be required to enlarge the opening made in the prostate.

FIG. 1399.



Knives of other shapes, preferred by different operators, are shown in Fig. 1399.

For extracting the stone two pairs of forceps must be at hand, one for the adult, and a smaller one for children (Fig. 1400), both moderately curved in the blades.

FIG. 1400.



Lithotomy forceps.

A scoop (Fig. 1401) will be required to extract the fragments should a stone break down under the pressure of the forceps.

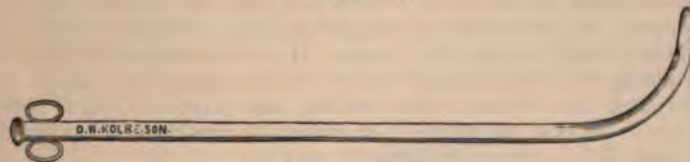
FIG. 1401.



Lithotomy scoop.

A catheter (Fig. 1402) is necessary for the purpose of injecting some tepid water into the bladder previous to the operation, and another, a gum one, with a large calibre, for washing out the bladder after the operation.

FIG. 1402.



Catheter for injecting the bladder.

The syringe used for injecting is the ordinary hard rubber one, holding

FIG. 1403.

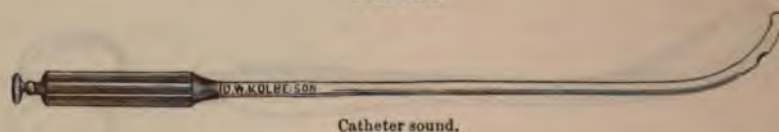


Catheter with Davidson's syringe.

four or five ounces, or an ordinary Davidson's syringe fitted to the end of the catheter (Fig. 1403).

An instrument (Fig. 1404) has been devised which, being hollow, aims to unite the sound and the catheter in one. It proposes to accomplish too much.

Fig. 1404.



It occasionally happens that a stone is too large to be drawn through the opening in the prostate: under these circumstances it becomes necessary to break the concretion into pieces before it can be extracted. For this purpose a large forceps with a screw attached will be required. (Fig. 1405.)

FIG. 1405.



Large forceps for breaking stone.

To the above-mentioned instruments must be added a tenaculum, ligatures, and sponges. These instruments, previous to beginning the operation, must be arranged on a tray in the order in which they will be required, and placed at a convenient distance from the operator, and alongside of an assistant detailed for the special object of handing and receiving them as they may be required.

The grooved staff is now to be introduced into the bladder, and if felt to touch the stone the sensation is reassuring, as it reveals the fact of the instrument being really within the viscus. It is not impossible that the staff in passing along the urethra might enter a false passage and slip in between the bladder and the rectum, thus leading the surgeon into a mortifying and fatal error: so that too much care cannot be observed in having the preliminary steps of the operation properly settled.

The staff is next intrusted to the hands of an assistant, who stands on the left side of the patient, and who, while steadying the instrument with one hand in the manner directed, holds the scrotum out of the way with the other.

The staff-holder plays a very important part in lithotomy. He should obey instructions implicitly; otherwise it is in his power to lead the operator greatly astray and cause irreparable damage to the rectum. The surgeon, before he commits the staff to the holder, takes the handle of the instrument in his own hand, introduces a finger of the other hand into the rectum, and with the two adjusts the guide in the place and in the position in which he desires it to be unchangeably held till the bladder is properly opened, and which is that up against the arch of the pubes, and nearly vertical, with the handle inclined very slightly towards the right groin. It will also be noted, while thus adjusting the staff, whether any feces have descended into the rectum: if so, the bowel should be cleared before proceeding to operate, so as to defend this part of the intestine against injury by the knife. The limbs of the patient are put in charge of two assistants, each of whom places a knee in the axilla and the clasped hands under the sole of the foot, and thus they are held apart and in a flexed position.

The surgeon now takes his place, either kneeling on one knee or sitting on a low stool, in front of the perineum (Fig. 1406), and, taking in at a glance

the raphe, anus, and tuberosity of the ischium, makes an incision on the side of the perineum, beginning on the side of the raphe about one inch in front of the anus, and carrying it back to a point midway between the tuberosity of the ischium and the edge of the bowel. This

incision should penetrate deeply into the tissues, unless the perineum is swollen, when it should be made with more reserve. As soon as the incision is made, the operator at once introduces the index finger of his left hand into the bottom of the wound, with the double object of defending the rectum which he at the same time presses backward out of the way of harm.

The deeper parts are divided by successive touches of the scalpel) and searching for the staff, on discovering which the point of the knife is to be thrust into the groove of the instrument along the finger of the digit, resting its inner edge. (Fig. 1407.)

The lodgment of the knife at this objective point having been safely effected, it is to be run a little distance up and down in the groove to render its position certain, and then, with its blade slightly inclined towards the ischium, is pushed steadily forward through the prostate into the neck of the bladder, the entrance to which is usually announced by a gush of fluid through the wound.

An error which is often committed during this stage of the operation is that of holding the knife as it glides along the groove towards the bladder too early parallel with the groove of the staff, thus making too small a wound in the prostate, instead of keeping it at first at a considerable angle and bringing it gradually to the parallel position towards the completion of the cut, in

FIG. 1406.



Position of patient, operator, and assistants in the operation of lateral lithotomy.

FIG. 1407.



Directing the knife into the groove of the staff.

which case the opening in the prostate will be amply large for the extraction. After the division of the vesical neck, the knife is to be withdrawn and the

FIG. 1408.



Forceps introduced and turned concavity upward previous to grasping the stone.

finger at the bottom of the wound carried along the staff into the bladder until its extremity comes in contact with the stone, when the staff must be removed and the forceps conducted along the finger into the organ. (Fig. 1408.)

It was at one time the practice both in England and in America to incise the prostate with the gorget. (Fig. 1409.) This was accomplished in the following manner. After opening the membranous portion of the urethra, the beak of the instru-

ment was introduced into the groove of the staff, previously laid bare, and, after running it up and down to make sure of its position, the surgeon

FIG. 1409.



Physick's gorget.

depressed the handle of the staff with his left hand, while with the right the gorget was pushed onward through the prostate body. Formerly, in the United States, this instrument was popular with Physick, Gibson, Barton, McDowell, Dudley, and others; but at present there are few surgeons who think of employing it. The knife, in point of dispatch, certainty, and security, is in every way preferable.

After the forceps have entered the bladder the finger must be withdrawn, and the blades of the instrument separated and closed over the calculus. In introducing the forceps into the bladder the convexity of the blades should be kept anteriorly, but after entering the organ the instrument is to be turned so as to bring the same surface posteriorly. In grasping the stone, it should be the aim of the surgeon to seize it by its smallest diameter, which can be determined only by the degree of separation in the blades of the instrument as the calculus is released and again caught.

The late Professor N. R. Smith, of Baltimore, used in the operation for stone an apparatus consisting of a catheter, a staff, and a lithotome all in one instrument. (Fig. 1410.) The catheter in its shape, being nearly rectangular, resembles the Buchanan staff. To the shank or handle of the catheter is hinged an incisor, which when pressed home enters a slot at the angle of the staff. The slot or groove as it runs forward towards the vesical extremity of the instrument winds round towards the left side. In the slot there is also a cup attached to a piece of spring-steel, which occupies the canal of the long arm of the instrument. In employing the apparatus in a case of stone the incisor is drawn back and the catheter introduced into the bladder; its angle can then readily be recognized in the perineum. While the staff is now firmly held in position, the incisor is pressed into the perineal tissues until its point enters the slot in the catheter, when it must be withdrawn and the lithotome conducted through the wound until its point enters the cup: it is then to be pushed onward into the bladder, the knob approaching the end of the

handle as the knife advances, a fact which shows that the lithotome is properly and securely following the groove on the staff.

FIG. 1410.



Professor N. R. Smith's lithotomy instrument.

Extraction.—In bringing the stone through the incision in the neck of the bladder it must be coaxed out by a gentle lever-movement of the forceps, conjoined with traction, during which counter-pressure by a finger applied to the lower edge of the wound in the prostate, thus slipping the latter over the surface of the calculus, will materially aid in the procedure. The line of traction should be backward towards the more ample outlets of the pelvis.

Some surgeons advocate stretching the prostate to any extent which may be required for the passage of the stone. A better term than stretching, perhaps, would be *laceration*, for this is much more likely to take place than stretching. It is better to make a free and clean section of the prostate, so that the calculus can be extracted without either tearing or bruising this body. The dilatability of the sphincter vesicæ which surrounds the neck of the bladder is very great, and it should not be cut. The evils of an opposite course are more likely to follow lithotomy in the adult than in the child, as in the latter the prostate is in a comparatively undeveloped state. In no instance, however, should the incision extend beyond the lateral lobe of the prostate. It is better, indeed, that it should not extend entirely through the lobe, as when it exceeds the limits of this body it will trench on the neck of the bladder and the recto-vesical fascia, and necessarily expose the patient to the danger of urinary infiltration and peritonitis.

In cases of deep perineum or of enlarged prostate, the finger of the operator may be too short to reach the bladder, even after the prostate has been sufficiently incised. Under such circumstances the edge of the closed blades of the forceps can be applied to the groove of the staff, and be thus conducted into the cavity of the organ. As soon as the forceps are found to move freely in the bladder, the staff must be withdrawn.

After the extraction of the stone it is the duty of the surgeon to explore the bladder, either with the finger or with a sound, to ascertain if another stone is present.

Encysted stone can be best dealt with by the finger inserted through the wound into the bladder, when it can be used both to lacerate the cyst wall and to detach the calculus.

Washing the bladder.—On the removal of a stone from the bladder, it is quite common for some scale or fragments to be ground off by the forceps before the concretion is delivered, or the calculus may crumble into pieces under the pressure of the extracting forceps. To make sure that no particle is allowed to remain and thus form the nucleus for another concretion, the bladder must be washed out with a solution of boracic acid thrown into the organ through a gum catheter introduced by the wound: the reflux current will carry with it whatever debris may have remained. It is a good practice to use the boracic solution for distending the bladder before operation.

Lithotomy in Children does not differ materially from that in the adult; but there are a few anatomical peculiarities belonging to very young people which must not be overlooked. These are, first, the less ample outlet of the pelvis, which necessitates more restricted incisions than would be allowable in adults; secondly, the smallness of the membranous urethra and the undeveloped state of the prostate body, on account of which the knife must be used with precision, opening this part of the canal in the proper direction and continuing the incision deliberately onward into the prostate. Any indecision, or any hacking with the point of the knife, may sever the membranous from the prostatic urethra or so divide it that it will be torn off in the extraction of the stone. Thirdly, the loose cellular tissue which forms the recto-vesical fascia allows the bladder and rectum to separate very readily, forming a cavity into which the finger may slip without resistance, conveying the false impression of being within the bladder. In consequence of the smallness of the prostate and the damage said to be done to the seminal ducts in this operation, I no longer introduce my finger into the bladder, but, after dividing the prostate, introduce along the groove of the staff a delicate stone forceps (Fig. 1410*), and extract the calculus.

FIG. 1410*.



Author's stone forceps.

Causes which may delay the extraction.—Occasionally a very large stone will be met with which cannot be extracted through the usual incision in the prostate. In such an event the opening in the latter body must be enlarged, or the calculus must be broken. If the size is not too great, the former plan should be adopted; and the cut should be made by a blunt-pointed bistoury, though at the same time too free incisions of the prostate are to be deprecated, as the knife may go beyond the limits of this body and open the pelvic fascia, thus exposing the patient to the dangers of urinary infiltration. To obviate this, the right lobe of the prostate may be divided obliquely outward and downward, the two incisions forming a triangular opening into the bladder, thus allowing of the passage of a large calculus. When the calculus cannot be drawn through the usual incision in the neck of the bladder, the crushing forceps can be used to break the stone, when it can be removed in pieces by the ordinary forceps. In judging of the fitness of a stone to be extracted, the surgeon must not be deceived as to its size. He must be certain that it has been grasped by its smallest diameter. The distance between the blades of the forceps when a calculus is seized in one direction will often be greatly lessened when it is caught in another diameter.

Position of the stone.—The inferior fundus of the bladder may lie so deep that difficulty will be experienced in bringing the blades of the forceps into contact with the calculus. This embarrassment can be overcome by inserting a finger into the rectum and raising the depressed part of the bladder, so as to bring the concretion into a more favorable position for extraction (Fig. 1411); or forceps having a more pronounced curve in the blades can be substituted for those in common use. If these fail, the scoop may be used.

Again, the stone may be lodged behind the pubes in a sacculated prolongation of the anterior wall of the bladder. Of course it would, in such a

location, be wholly inaccessible to the extracting forceps, and would require for its dislodgment and removal pressure with the fingers above the pubes, with or without the assistance of an abruptly-curved scoop. When the calculus is lodged in a pouch or sac formed in the walls of the bladder, the scoop will again be called into requisition for its extraction; and when encapsulated, as occurred in my own practice in one instance, the investing wall will require to be lacerated, and the concretion shelled out with the finger.

Vicious formation of the pelvis, such as occurs in children who have suffered from rickets, is another cause rendering the removal of a calculus a matter of difficulty. In this condition the obstacle may consist either in the close approximation of the rami of the pubes and ischium, or in an extreme contraction in the antero-posterior diameter of the pelvis. The remedy will consist either in breaking up the stone or in opening the bladder above the pubes.

Several calculi.—When a number of stones exist at the same time in the bladder, they are to be removed by the repeated introduction of the forceps; and this may prove a cause of delay.

Peculiarities in the shape of a stone will sometimes render its extraction a matter of delay and difficulty, as when there projects from its surface a long spike or process which, when an attempt is made to pull it through, catches on the side of the opening in the prostate. Or an irregularity of this nature may prevent the proper application of the forceps to the stone. A finger inserted into the bladder, so as to admit of an examination of the concretion, will reveal any irregularity of the kind alluded to, and the remedy will consist in crushing off the process by the forceps or the lithotrite and removing the parts separately.

Diminutive stones.—A calculus may be so small that when the bladder is opened the concretion will be carried through the opening by the force of the current of water which gushes out, and either become fixed in some part of the external wound or fall into the vessel placed at the foot of the table for receiving the blood and other discharges, thus subjecting the surgeon to the mortification of delay in a further search of the bladder. In one instance I saw a small stone projected with such force from the bladder that it was buried in the cellular tissue at the base of the scrotum and was not discovered until it had created an abscess by its pressure. In another instance which I recall, the surgeon was about to conclude that he had committed an error in diagnosis, not finding the calculus in the bladder, after lithotomy had been performed, when, on searching the bucket beneath the table, the concretion was discovered.

Vesical incrustation.—A phosphatic incrustation of the inner surface of the bladder is sometimes seen to exist along with a free calculus, and must necessarily retard the work of clearing out the débris. I have seen several ounces of calcareous matter adherent to the mucous surface of the bladder after an operation for stone. This material is most satisfactorily detached by the scoop, sometimes by the finger, and demands the free injection of tepid water into the organ in order to wash out all the fragments.

Tumors of the prostate may offer an obstacle to the finger reaching the bladder, in which event the procedure adopted in a case of a very deep perineum must be practiced, namely, that of sliding the forceps into the organ along the groove in the staff.

AFTER-TREATMENT.—After the removal of the stone and the control of

FIG. 1411.



Stone in the inferior fundus of the bladder.

any bleeding which may continue, the patient should be placed in the bed, which must be properly prepared for his reception. For this purpose a hard mattress, covered with a piece of gum-cloth, and over this a sheet, answers best. In order that the patient and his bed may be kept dry, a draw-sheet rolled up on one side and placed across the bed, under the hips, will be required. This, as often as it becomes wet with the urine, must be drawn from beneath the buttocks and the soiled portion rolled up, the sheet being replaced by another as soon as the clean rolls become exhausted. I sometimes find it advantageous to press beneath the nates a large sponge, two thirds of which (the portion resting on the bed) is inclosed in an oiled-silk bag. When the sponge becomes soaked with the urine, it can be removed from the bag and a clean one placed in its stead. To prevent excoriation of the soft parts from the contact of the urine, the hips should twice a day be smeared over with benzoated oxide of zinc ointment. The position which is most comfortable to the patient is on the back; although I never object to his turning on the side if that is preferred. There is no necessity either for tying the knees together or for introducing a catheter through the wound into the bladder. For the first two days the water usually escapes freely through the cut. After this, for two or three days it will probably flow also through the urethra, in consequence of the inflammatory swelling succeeding the operation temporarily closing the prostate. With the subsidence of this the wound in the prostate body again begins to gape, and the urine resumes the original course through the incision, and so continues to flow until the latter is gradually closed by granulation. It then follows the natural channel through the urethra.

The time required for healing the perineal incision varies from three to six weeks. In several instances union by first intention has been observed. Crichton, in an aggregate of 200 operations, witnessed this mode of healing twenty-three times,—an experience which I imagine is quite exceptional. In children I have seen the cut close as early as the fourteenth day. It is a good rule not to allow the patient to sit up until the wound has healed, as otherwise a fistula may follow.

After the patient has been placed in bed, an opiate ought to be administered, to be repeated as often as may be necessary to relieve pain. The bowels must be kept in a quiet state for at least four days, after which they are to be opened by a laxative of oil or Rochelle salt. The diet for the first few days should be light and unstimulating, as milk, after which a more liberal allowance can be prescribed, consisting, in addition to the milk, of broth and eggs. By the beginning of the second week solid and more substantial articles of food will be admissible.

ACCIDENTS DURING LITHOTOMY.—The first I shall mention is *hemorrhage*. There is always some hemorrhage in every operation of lithotomy. The source of the bleeding is the transverse perineal artery, which is necessarily divided when the knife severs the transverse perineal muscle. In most cases the vessel will not require a ligature, as the flow of blood ceases spontaneously. If this should not be the case, however, the vessel must be drawn out with a tenaculum and tied. In some instances, in consequence of a long-continued vesical irritation, this artery becomes greatly enlarged, and will give rise to a very profuse hemorrhage: in such an event the surgeon should tie the vessel before proceeding further with his operation.

Independently of the transverse perineal, the vessels which are prone to give trouble are the artery of the bulb, the internal pudic, those of the bulbous portion of the corpus spongiosum, the prostatic plexus of veins, and the inferior hemorrhoidal arteries. The resources for stopping undue bleeding at the command of the surgeon are cold, heat, the ligature, the forceps, and compression.

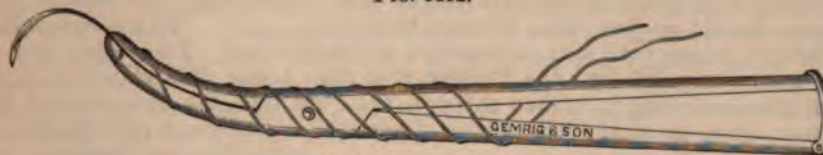
Cold.—Cold may be applied by the introduction into the wound of lumps of ice, or of lint soaked in cold water; or a stream of cold water may be thrown in by a syringe.

Heat.—When cold fails to effect the desired end, heat will sometimes suc-

ceed, and may be applied by thrusting deeply into the wound a pledget of lint previously saturated with boiling hot water, and allowing it to remain for a few moments. The temperature, to prove effectual, must be such as can be barely borne by the hands of the surgeon.

Ligature.—The application of a thread to the transverse perineal artery or to an opening in the bulb is not a task of any great difficulty, as either is quite accessible to the tenaculum or the forceps. But when the *arteria bulbosa*, or the internal pudic, from which the former is derived, is injured, not only will the bleeding be copious and dangerous, but ligation will be very difficult. In dealing with the first-named vessel it may be necessary to enlarge the wound in an upward direction, so as to render it more accessible: it is preferable, however, to watch the point from which the blood issues, the sides of the wound being held asunder and in a good light, and to include the point, along with some portions of the surrounding tissues, in the grasp of the blades of a pair of dressing forceps, which can be locked together and allowed to remain for thirty-six hours in the wound, as practiced by Professor Gross. When the internal pudic artery has suffered (an accident which can occur only by lateralizing too much the edge of the knife), the ligature becomes imperative. This vessel is large, and is sheltered under a strong fascia by the inner edge of the ramus of the ischium. It is accompanied by a vein and by the internal pudic nerve. Thrice have I been called to ligate this vessel. The instrument usually depicted as that particularly suited for this operation, and commonly known as Physick's forceps and needle (Fig. 1412), is not at all adapted to this purpose, nor is there any evi-

FIG. 1412.



Physick's forceps and needle.

dence that it was ever used in tying the vessel by the distinguished surgeon whose name it bears. The only instrument well adapted to this ligation is *Horner's awl*. (Fig. 1413.) This consists of a strong curved awl-shaped

FIG. 1413.



Horner's awl.

needle, having a shoulder near its extremity, and mounted on a stout handle. A thread is first looped over the shoulder of the instrument, after which the point of the needle is passed along the inner side of the ramus of the ischium, half an inch in front of the tuber, and made to emerge on the hither side of the vessel, the point of the needle being at the same time directed sufficiently towards the surface to enable the surgeon to disengage the loop of the ligature from its shoulder, when the instrument is to be withdrawn and the thread tied. The ligature of the internal pudic would command also the circulation through the artery of the bulb.

Pressure.—Pressure can be employed either through the wound or through the rectum. When made in the wound, it can be done by a catheter and strips of lint, by the chemise, or by the air tampon.

When the first plan is resorted to, a gum catheter of good size is conducted by the finger through the wound a short distance into the bladder,

after which one end of a long strip of patent lint is carried down on the point of a director to the bottom of the wound, and the remaining portion pushed in by installments until the whole piece is firmly packed in around the catheter.

The chemise is made by making an opening in the centre of a square of muslin, passing through this a gum catheter, and securing the two together about two inches and a half from the end of the tube by a thread. (Fig. 1414.)

FIG. 1414.



The end of the catheter is passed into the bladder as far as the chemise, and the latter packed with one or more strips of lint or linen.

Whether the catheter and lint, or the chemise, is used, neither should be permitted to remain longer than twenty-four, or, at furthest, thirty-six hours. In their removal the

proper mode of proceeding is to seize the free end of the strip used in the packing, and slowly withdraw it without the least rudeness. The advantage of having the packing to consist of a single piece will be apparent when the time for its withdrawal has arrived, as it does not necessitate the introduction of the dressing forceps into the wound.

The *air tampon*, the device of Mr. Buckstone, constitutes a very effective arrangement for the distribution of pressure. This contrivance is made by securing to a stout rubber catheter or tube a gum bag; the ends of the former should project some distance beyond the latter. To the elastic bag is fitted a rubber tube with a stop-cock at its free end. The vesical end of the tube is carried into the bladder, and, after being thus placed in position, the elastic bag is inflated through the gum tube, the distention of the former acting on all the inequalities of surface of the wound and effectually

FIG. 1415.



Buckstone's tampon.

controlling the bleeding. As with the catheter and lint, or with the chemise, twenty-four or thirty-six hours will be quite long enough to maintain the pressure, which can be gradually moderated by allowing a little air from time to time to escape through the stop-cock. (Fig. 1415.)

Pressure through the rectum was first practiced by Dr. Kerr, surgeon to the hospital at Canton, China. It is also a potent means of arresting hemorrhage. This can be satisfactorily demonstrated by inserting a finger into the

rectum in a case of obstinate bleeding after lithotomy, and pressing the anterior wall of the bladder firmly towards the pubes, when the flow will immediately stop. Dr. Kerr's plan was to substitute the pressure of the finger by packing the bowel with old linen or lint.

The practice of soaking lint or bits of sponge with styptics, as the salts of iron, and pushing them into the deep parts of the wound, is to be deprecated, leaving as it does a dirty incrustation adherent to the tissues. Indeed, all methods of applying pressure to a lithotomy wound are to be regarded as complicating the case, though they are often the better choice of two evils.

Failure to enter the bladder.—This has frequently occurred, and is more likely

to attend the operation in children than in adults, in consequence of the greater mobility of the bladder and the rectum, and the loose connection between them. The error arises from the opening into the urethra not being made sufficiently free, so that the finger, and sometimes the forceps, glides into the recto-vesical fascia. It is an unfortunate mistake, and is liable to be followed by urinary infiltration, pelvic cellulitis, peritonitis, and death. An accident of this nature can be easily avoided by remembering that when the finger is in the proper route to the bladder it will feel the *button-hole grip* of the sides of the prostate, very different indeed from the sensation produced by contact with the loose, unresisting walls of the recto-vesical space. There will also be felt, when the finger is on the right way to the bladder, the bare staff and the surface of the stone. Should an accident of this kind befall an operator, it will be imperative, after the mistake has been corrected and the calculus removed, to keep, during the first week, a catheter in the bladder, passed through the wound, in order to conduct away the urine and prevent its extravasation into the cellular tissue of the pelvis.

Opening the bladder beyond the prostate.—This may be done by continuing the incision through the prostate and onward into the neck of the organ, or the urethra may be missed altogether and the organ penetrated posterior to the prostate body. The sequences of so grave a miscalculation are the same as those which follow opening up the recto-vesical space. They are likely to prove fatal.

Wound of the rectum.—This accident has often happened. It is sometimes the fault of the staff-holder, who fails to keep the instrument well up under the arch of the pubes, and thus allows the prostate and the rectum to be in too close contact, so that the bowel is cut as the knife is pushed onward along the groove of the staff. Or the fault may lie wholly with the operator, who either fails to press the intestine sufficiently aside with the left index finger when the deeper incisions are being made, or does not at this stage of the operation lateralize his bistoury to the proper extent. The accident would also be favored by the bowel being distended with feces at the time of the operation. I have known the rectum torn during the forcible efforts made to extract a large, rough stone. The higher the wound in the bowel, the less probability is there of the patient deriving any benefit from treatment. A recto-vesical fistula will follow, with all the evils resulting from the passage of the urine into the rectum, and of the contents of the latter into the bladder. When the opening happens immediately above the sphincter, the case is much more promising: there is a probability of its closing up as the granulations approach the surface. Should this not follow, the proper treatment will be, after the wound in the perineum has healed up, in an ordinary anal or rectal fistula, to lay open the bowel and the wound into one, and to extend the incision through the sphincter to the surface of the perineum. When the opening is high up and very small, the actual cautery is worth a trial. In one case I have seen it succeed; but the hot iron must be withheld until the opening has contracted to its smallest dimensions, which will require several months.

These recto-vesical fistulae predispose the patient to another attack of stone, in consequence of foreign substances entering the bladder from the rectum and supplying a nucleus for the deposition of the urinary salts.

ACCIDENTS FOLLOWING LITHOTOMY. 1st. *Retention of urine.*—The opening in the prostate may be made so small that when the inflammatory swelling which succeeds the operation sets in, there may not be sufficient space for the escape of the urine; or, as in a case which I recently witnessed, the retention may be occasioned by a fibroma at the neck of the bladder, which, after the removal of the stone, will project both into the wound in the prostate and into the urethra. The cessation in the escape of urine through the incision, the distention of the bladder, which can be felt above the pubes, and the pain and fruitless efforts to urinate, will sufficiently indicate what has happened. The remedy is catheterization through the urethra, which will require to be repeated until the urine resumes its course through the cut.

2d. *Pelvic cellulitis* (by which is meant diffuse inflammation of the connective tissue about the prostate body, the vesiculæ seminales, the bladder, and the fascia connecting the bladder and rectum as high as the reflection of the peritoneum) may arise from various causes. The most common are the extravasation of urine—due either to prolonging the incision beyond the limits of the prostate body, or to disturbing the recto-vesical fascia by the finger or forceps, thus destroying the natural barrier to the upward intrusion of the urine—and the rough, forcible extraction of large stones, thus damaging the prostate. A case of pelvic cellulitis may originate in a phlebitis of the prostate veins, which becomes at length propagated to the connective tissue, or in disease of the kidneys. A general vitiated state of the health is no inconsiderable factor in the production of this condition. It appears generally before the third day, and is announced by rigors, high febrile excitement, sweating, hiccough, a dirty, sallow complexion, and great prostration, accompanied by passive delirium. The inflammation is followed by suppuration and gangrene of the cellular tissue of the pelvis, peritonitis often destroying the patient by septicæmic or pyæmic poisoning.

The treatment must be based on general principles, giving exit to any accessible purulent accumulation by incisions, disinfecting the parts by injections of a solution of permanganate of potash, sustaining the strength with concentrated nourishment, stimulants, and tonics of quinine and iron, and relieving pain and restlessness by opiates.

Diphtheritic deposition.—In seasons when diphtheria is prevailing, the wound of a lithotomy patient is liable to become covered with the peculiar exudation. This may occur quite independently of constitutional symptoms; though the contrary is oftener the case.

Local applications, other than those which are required from motives of cleanliness, do no good in cases of this nature. The surgeon must rely on general treatment, as the free use of chlorate of potash, iron, and capsicum, with milk, beef-tea, brandy, and wine.

Sloughing.—When the tissues have been extensively bruised in extracting a calculus (particularly in a person whose system has been broken down by intemperance and other excesses), or where in consequence of some complication the frequent introduction of the forceps has been necessary, the vitality of the parts may be so seriously impaired as to induce mortification. From causes of this kind I have seen extensive sloughing take place, in one instance laying open the rectum.

In cases of this character, in addition to frequent ablutions with disinfecting solutions and the prompt removal of any detached shreds of disorganized tissue, the patient will require tonics, stimulants, opiates, and a supporting diet.

Inflammation of the prostate.—It is a matter of surprise that this body does not share in the evil effects of operation for stone more frequently than observation proves to be the case. What with the violent stretching, lacerations, multiple nicks with the knife, and bruising while the calculus is being drawn through, it is certainly subjected to much traumatic violence. Unless when a partially detached portion of the prostate is found hanging loose (when it should be clipped off), or when a fibroma imbedded in its substance has been in some measure enucleated (in which case its removal will be demanded), the correction of the injury may be safely left to the natural process of repair.

Cystitis.—There is always present in cases of stone some degree of cystitis. This is not unfrequently increased for a short time through the effects of the wound inflicted in lithotomy. It is, however, exceedingly uncommon to find the inflammation of the bladder continue long after the extraction of the calculus, except in old cases of stone. The foreign body once removed, the cystitis soon subsides.

Hæmorrhage into the bladder.—Blood sometimes, instead of escaping externally, finds its way into the bladder, and the viscus may become greatly distended with clots, giving rise to much straining and vesical distress. When the patient is unable to expel the coagula, a catheter should be introduced

into the bladder through the urethra and the clots broken up, so as to favor their escape through the wound.

Suppression of urine following operation for stone is always an alarming circumstance. Though generally associated with disease of the kidneys, it may nevertheless occur in a healthy state of these organs. In either condition it is an evidence of profound nervous shock, and is announced by rigors, sweating, headache, thirst, vomiting, and pain in the lumbar region, followed by delirium, stupor, absence of urine, coma, and death, the fatal result sometimes occurring in thirty-six or forty-eight hours.

The treatment consists in applying over the loins hot poultices containing leaves of digitalis, and the internal use of diuretics, as acetate of potash or infusion of digitalis. If stimulants are demanded to counteract the prostration, Holland gin will be the most efficacious.

Incontinence of urine is occasionally witnessed after lithotomy, particularly in young subjects, and is due either to injury sustained by the sphincter vesicæ, or to the over-stretching of the prostate during the delivery of the stone. This incontinence is much more annoying during the day than during the night, the recumbent position being apparently favorable to the retention of the urine. The disability usually passes away as the work of repair advances.

Orchitis.—Inflammation of the epididymis or of the testes, when present, may either be the effect of injury to the prostate, or may result from some irritation affecting the urinary passages independent of the operation. When it comes on in twelve or fourteen days after the cutting, the latter is generally the case. The treatment will not differ from that proper to orchitis arising from other causes.

Peritonitis after lithotomy, though not common, may occur when the recto-vesical fascia has been much disturbed. It may also originate from the bruising of the prostate, or from counter-puncture of the walls of the bladder,—an accident which arises from keeping the point of the knife in too horizontal a direction, and in carrying it backward too far when the viscus is empty and collapsed. Tympanitis, abdominal tenderness, a quick, corded pulse, flexed limbs, and constipation reveal the inflammation of the peritoneum, which must be met by leeching, and subsequently by blistering the abdomen, also by the use of hot poultices, and of opium in sufficient quantities to allay pain and restlessness.

Pyæmia is one of the sequences of lithotomy. It generally occurs in patients of intemperate habits, or in those whose health has been seriously impaired by previous disease. It is ushered in by a sharp rigor, high temperature, a frequent pulse, sweating, prostration, and probably an icterode state of the face and conjunctivæ.

The treatment must be a sustaining one throughout, embracing tonics of quinine and iron, stimulants, and liquid nourishment.

Sexual defects.—It is not often that any complaint is heard from persons cut for calculi as to the operation having affected their potency in the sexual act. When sterility or impotence does occur as a sequel of lithotomy, it must be referred to some injury of the seminal ducts, to inflammatory changes in the prostate, or to a fistula, into which the spermatic secretion is discharged during ejaculation. There is no remedy likely to remove the difficulty.

Fistula.—The perineal wound may fail to heal entirely, leaving a fistulous tract, which in some instances is so small as scarcely to admit the smallest probe, and through which only a very small amount of water passes during urination. The opening will often close up without any application, even though the patient is allowed to go about. Should this not be the case, the opening will require to be stimulated by passing along the tract once or twice a week a silver probe dipped in nitric acid. Passing the water on the hands and knees, or when lying on the right side, to divert the urine (as is supposed) from the opening, is a useless precaution. The defect is

not in the bladder, but in the prostatic urethra: therefore posture cannot affect the stream of water in this part of the channel. A more valuable device is the application of pressure against the prostate when urinating, by a finger inserted into the rectum, or, what is next best, on the perineum, immediately in front of the anus. If these measures fail, the water must be drawn at stated intervals with the catheter for eight or ten days. As a last resort, the fistulous tract may be laid open with the knife down to the prostate body, and the urine subsequently drawn with the catheter, until the wound closes by granulation tissue. This will generally succeed in effecting a cure.

Phosphatic incrustation.—The edges of a lithotomy wound may become incrustated with phosphates. These are best removed by a wash of three or four drops of muriatic acid to the ounce of water.

Mortality.—The circumstances which affect the mortality in lithotomy are age, disease of the urinary organs, the size of the calculus, and the general health of the patient. The individual skill of operators, doubtless, must not be ignored in the enumeration of results obtained from this operation. In 5149 cases of lateral lithotomy performed in twenty-one hospitals and tabulated by Gross, there were 4461 recoveries and 688 deaths, a mortality of 15.42 per cent. Cheselden, who took the initiative in popularizing the lateral operation for stone, lost 20 cases in 213 operations, or 9.38 per cent.

Between the years 1875 and 1881 there were reported in various medical journals, domestic and foreign, 1192 cases of lateral lithotomy, with 106 deaths, or 8.89 per cent. More recently Dr. Altonnian, of Turkey, gives 272 cases, with 15 deaths; and Surgeon-Major Keilan reports 188 cases done in the Hyderabad Hospital, Sind, India, between June 1, 1886, and May 31, 1887, with 8 deaths. Adding all these cases to 10,150 collected by Gross from the tables of various operators from Cheselden down, we have 11,802 cases of lateral lithotomy, with 1243 deaths, a mortality of 10.5 per cent.

Age constitutes a potent factor in the mortality of lithotomy. The tables of Coulson, which embrace 2972 cases, exhibit a death-rate of 1 in 13 cases of patients under ten years of age; from ten to twenty, 1 in 9; from twenty to thirty, 1 in 6; from thirty to forty, 1 in 5; from forty to fifty, 1 in 4; from fifty to sixty, 1 in 3.65; from sixty to seventy, 1 in 3.23; from seventy to eighty, 1 in 2.71. The average for all ages in Coulson's cases is 1 in 9, or 11.11 per cent.

Sir Henry Thompson, in an analysis of 1827 cases collected from the hospitals of Great Britain, estimates the death-rate at 1 in 17½ for patients under eleven years of age; between twelve and sixteen, 1 in 9½; from seventeen to twenty-nine, 1 in 7½; from thirty to forty-eight, 1 in 7½; from forty-nine to seventy, 1 in 4½; from seventy-one to eighty-one, 1 in 3½; the average mortality of the whole being 1 in 8.

Of 217 cases collected for me by Dr. Baum, 50 were under five years of age, of which number 49 were cured and 1 died. The average age of these 50 cases was 3½ years. Of 54 cases between five and ten years of age, 53 recovered and 1 died; the average age being 6½ years. Of 27 cases ranging from ten to twenty years, 26 were cured and 1 died; the average age being 13½ years. From the age of twenty to thirty years, there were 11 cases with 9 cures and 2 deaths; from thirty to forty, 5 cases, with 4 cures and 1 death; from forty to fifty, 9 cases, with 8 cures and 1 death; from fifty to sixty, 18 cases, with 13 cures and 5 deaths; from sixty to seventy, 28 cases, with 21 cures and 7 deaths; from seventy to eighty, 13 cases, with 11 cures and 2 deaths; over eighty, 2 cases, with 2 cures. Dividing these 217 cases into two groups, it will be seen that 131 were under twenty years of age, only 3 of whom died, while of 86 ranging in age from twenty to over eighty, 18 died; the mortality for the whole number, 21, being 9.67 per cent.

Size and weight of calculus.—The bulk and density of calculi also exert a material influence on the results of lithotomy. This fact has been well

brought out in the tables of both Crosse and Garden. In the former, of 704 cases of lithotomy performed in the Norwich Hospital, it was found that the mortality when the stone did not exceed one ounce was 1 in 11 cases; when not exceeding two ounces, 1 in 61 cases; from two to three ounces, 1 in 218 cases; from three to four ounces, 1 in 157 cases; and from four to five ounces, 1 in 166 cases. The tables of Dr. Garden, the data of which were drawn from the Saharunpore Hospital (and which embrace 625 cases having a bearing on the subject under consideration), furnish substantially the same results. The deaths following the extraction of these large calculi are for the most part due to pelvic cellulitis, the result of laceration of the prostate, and of urinary infiltration.

Disease of the kidneys.—A patient suffering from disease of the kidneys is a dangerous subject for lithotomy, and nothing but the direst necessity should induce a surgeon to attempt any cutting operation for stone. Such persons should be relegated, in most instances, to the domain of lithotripsy.

General bad health, proceeding from cardiac or hepatic disease, from diarrhoea, from intemperance, or from any cause seriously affecting the nutrition of the body, will materially lessen the prospects of recovery in a patient who is the subject of lithotomy.

Surgical skill constitutes another element of success. In this I would include not only the operative tact which enables the surgeon to execute, by clean and well-directed incisions, the division of the perineal and vesical structures and the extraction of the calculus without unnecessarily damaging the bladder or the prostate, but also the exercise of a discriminating judgment in the selection of proper cases for cutting, together with a watchful and judicious management of the case after the operation has been performed.

Dudley, in 207 cases, is said to have lost only 6, or 1 in $34\frac{1}{2}$; Mott, in 162 cases, lost 7, or 1 in 23; Mettauer, in 91, lost 4, or 1 in $22\frac{1}{2}$; Gross, in 140, lost 12, or 1 in $11\frac{1}{2}$. The average mortality with American surgeons, based on an analysis of 2303 cases, is about 1 in every $14\frac{1}{2}$.* This is almost identical with the death-rate of an eminent native Indian surgeon, Raj Ran Nasian Dass Bahadoor, of Calcutta, who in 248 cases of lateral lithotomy lost 17, or 1 in $14\frac{1}{2}$. G. Bainbridge, of India, in 199 lateral lithotomies, lost 6 patients, —a death-rate of nearly 3 per cent.

The most remarkable success attained by any single operator is that of Martineau, of Norwich, England, who lost only 2 in 84 cases. Thompson, however, who has carefully analyzed the cases of this operator, finds that 34 were under fifteen years of age, 6 were females, and not over 12 were more than sixty years of age. Such a revelation lessens very much our surprise at what, under other circumstances, would seem a very exceptional success.

Dudley lost only 6 patients in 207 cases, or 1 in $34\frac{1}{2}$; but about 150 of these were under fifteen years of age. Professor Gross, in 66 operations on children, lost but 1 case.

Success is sometimes attributed to luck, or good fortune, as it is termed, but, although the planets do not rule in the domain of surgery, and good results are generally attributable to the skill and judgment of the operator, no amount of manual dexterity in the use of the knife or of professional wisdom will prevent a certain number of patients from dying. It is very unwise for a surgeon to become too much elated by a long run of success. For several years—one year seven times—I cut patients for stone without the loss of a single case, when I became disposed to criticise the average mortality of the operation; but immediately afterwards I lost three cases in rapid succession.

The season of the year has sometimes been supposed to exert some influence on the mortality of lithotomy. I find, however, no sanction for this belief in the records of the operations which I have examined.

Relapse.—In 4902 cases of lithotomy, drawn from the statistics furnished by Mr. Williams from the Norfolk and Norwich Hospitals, from those also of

* Gross on the Urinary Organs, p. 275.

two great hospitals in France,—La Charité and Lunéville,—from the Sahnunpore Dispensary, India, and from 1100 cases which I have had collected from various sources since 1875, only 45 relapses are noticed,—less than 1 in every 100. No reliance, however, can be placed upon statistics of this kind. Many persons cut for stone pass from under the observation of the original operators and fall into the hands of other surgeons, while no record is kept of their history which ever finds its way into those channels which are accessible to statisticians. It is in the highest degree probable that a much larger ratio of relapses occurs than is represented in tables constructed with a view, in part, of developing this information. In two instances I cut patients who had been twice operated on before,—one a man over seventy, and the other in middle life. Twice I have performed lithotomy in children who had been subjected to the operation once before. The most extraordinary instance of multiple lithotomy was that of a military surgeon, Maldigny, reported in the "London Medical and Surgical Journal," vol. v. p. 264. He had been the subject of lithotomy six times, and of lithotripsy twice. Once the patient cut himself, guided by the reflection from a mirror placed beneath the perineum, and extracted a calculus from the neck of the bladder.

A person who is left after lithotomy with a fistula, or one who, suffering from chronic cystitis, has been the subject of phosphatic calculus, is liable to a return of the disease. It has happened in some cases that a second stone, or a fragment of a broken one, has been overlooked at the time of the operation, and the reappearance of the vesical symptoms of stone has been ascribed to relapse. In other cases when relapse follows, the surgeon may be subjected to very unjust criticism, under the impression that he failed to discover all the concretions present at the time the lithotomy was done.

As an illustration of this, I may mention that I once cut a child for stone, extracting a calculus the size of a pigeon's egg. Symptoms indicative of the presence of a second concretion reappeared after the lapse of three months. I again operated, removing a second stone quite as large as the first. The little patient recovered from the operation, but died six months later from disease of the kidneys. The autopsy explained the apparent relapse, the left ureter was enormously dilated and packed with calculi of considerable size. It was from this source that the two calculi which had been formerly removed had come.

Indeed, stone, depending as it generally does on a disturbed or deranged condition of the digestive apparatus and a faulty action of the kidneys, might very naturally be expected to recur.

Median Lithotomy.

In median lithotomy the incisions are made in the middle of the perineum, beginning in the raphé between the scrotum and the anus. This operation was first proposed by Manzoni, a surgeon of Verona, Italy, in 1808, and afterwards practiced by two of his countrymen, Rizzoli and De Borsa. It is sometimes described as a revival of the old Marian method, or that performed by Marianus Sanctus, who, it is said, learned the route to the bladder from his preceptor, Franciscus de Romani, of Cremona, Italy. It was also known as the method by the *apparatus major*. The modern operation, however, differs from the Marian in the simplicity of the instruments with which it is executed.

As performed by De Borsa, the patient was placed in the same position as for the lateral operation, on the back, with the limbs flexed on the body and abducted. A staff, with its groove in the centre, was passed into the bladder, and held by an assistant well up under the pubic arch, while the surgeon made an incision in the median line extending from the scrotum to the anus, which was carefully deepened until the membranous part of the urethra was reached; this was freely opened along its whole extent on the groove of the

staff, a distance of about three-quarters of an inch. This done, the index finger was carried along the staff into the bladder, dilating in its progress (by a series of boring movements) the prostatic portion of the urethra. As soon as the bladder had been reached, the staff was withdrawn, a pair of forceps conducted into the viscus along the finger as a guide, and the stone seized and extracted. It will be readily perceived that such an operation is adapted only to the extraction of calculi of small size. A large stone could not fail to lacerate the prostate during its passage through that body, an accident which is also likely to occur at the time of the forcible introduction of the finger. This plan is sometimes termed *lithectasy*. Vacca, in order to avoid an accident of this nature, extended his incision beyond the limits of the membranous portion of the urethra into the prostate body. Mr. Allarton, of England, performed this median operation in a manner somewhat different from that of De Borsia. Instead of making formal incisions from the surface inward, he introduced the index finger of the left hand into the rectum, allowing its tip to rest against the anterior surface of the prostate and upon the staff. A long, straight, double-edged knife was next thrust into the perineum about five-eighths of an inch in front of the anus; this was carried steadily onward and a little upward, until its point, guided by the finger in the bowel, entered the groove of the staff, when it was made to divide the front of the prostate, the external wound being enlarged to the extent of one inch in a downward direction. As the knife was withdrawn, a long ball-pointed probe was passed through the wound into the bladder along the groove of the staff; after which the latter was removed, and a finger inserted into the incision and carried down to the probe and along the latter into the bladder, when the forceps were introduced along the finger and the calculus removed. When the calculus was large, Mr. Allarton used either the three-bladed female dilator of Weiss or the hydraulic expander of Arnott, in order to stretch the prostate. Teale and Dolbeau also employed instruments for dilatation.

Much harm would be likely to follow such procedures, especially in children, in whom the prostate is small and the fascial attachment of the neck of the bladder loose. In his later operations Mr. Allarton discarded all dilators except the finger, and also insisted in cases of large stone on breaking the calculus before attempting its extraction. In this country the median operation was practiced almost exclusively by the late Dr. Walters, of Pittsburg. In New York it has received the support of Dr. Markoe and of Dr. Little.

The advantages which are thought to belong to this operation are—first, the little danger of hemorrhage, from there being no vessels of magnitude in the track of the incisions; secondly, confining the nicking of the prostate to the middle line of the body; thirdly, the slight risk of wounding the vesiculæ seminales, and the trifling disturbance of the recto-vesical fascia, thus lessening the probability of urinary infiltration; fourthly, the simplicity of the procedure.

On the other hand, there are certain disadvantages connected with the median operation which render it inferior to the lateral method. First, the space between the neck of the bladder and the rectum is so narrow that the latter is greatly exposed to injury below, while the bulb of the penis is equally in danger in front. In children this objection is particularly forcible. Secondly, the bladder is more liable to be pushed before the finger during the efforts made to enter its cavity, and the prostate more likely to be torn, than in lateral lithotomy. Finally, it is entirely unsuited to the extraction of large stones, as has been shown by Mr. Williams, who, in analyzing the cases of stone operated on by the median plan at the Norfolk and Norwich Hospitals, found that only in a single instance did a patient survive when the stone exceeded three drachms and a quarter in weight, or when the long diameter of the stone exceeded one and one-half inches and the short diameter one and one-eighth inches. In the instance referred to, the calculus weighed four and one-eighth ounces, and its extraction was followed by sloughing of the rectum and perineum, and the entailment of a perineo-recto-

vesical fistula. As to the healing of the wound, the time required for that purpose differs very little in the median and lateral methods.

In determining the value of the median operation, resort must be had to statistical information. The tables of Mr. Allarton, numbering 170 cases, are not admitted even by English authorities as furnishing reliable data for the decision of this question. Mr. Williams has collected 64 cases of median lithotomy performed at the Norfolk and Norwich Hospitals, of which number 13 died, or nearly 1 in 4. Of 64 lateral lithotomies performed in the same hospitals and under, approximately, the same conditions as to age, etc., 8 died, or 1 in 7.

Still later, McCadge, from the same hospitals, collected 90 cases of median lithotomy, of different ages, with 16 deaths,—a mortality of 17.77 per cent.

The table of Gross, which includes the 64 cases of Mr. Williams,* with 205 drawn from the practice of American surgeons, 56 from Reyer, of Cairo, and 25 from Pemberton, of Birmingham, constituting in the aggregate 350 cases of median lithotomy, furnishes 318 recoveries and 32 deaths, or 9.14 per cent., which is a higher mortality than that following lateral lithotomy if the death-rate of the latter is 1 in 21, as appears to be the case.

The following cases of median lithotomy have been published since January 1, 1875:

No.	Age.	Weight of Stone.	Recovered.	Died.	Source of Information.
1	2½ years	150 grains.	1		
1	2½ "	30 "	1		
1	3 "	20 "	1		
1	4 "	135 "	1		
1	5 "	65 "	1		
1	6 "	102 "	1		
1	7 "	120 "	1		
1	9 "	135 "	1		
1	10 "	135 "	1		
1	10 "	370 "	1		
1	10 "	79 "	1		Lancet, March 18, 1876, p. 423.
1	11 "	380 "	1		All done at Lexington Infirmary.
1	11 "	212 "	1		
1	40 "	750 "	1		
1	50 "	436 "	1		
1	60 "	232 "	1		
1	61 "	Not stated.	1		
1	62 "	" "		1	
1	63 "	325 grains.	1		
1	70 "	495 "	1		
1	35 "	3 stones, each ½ inch in diameter.	1		British Medical Journal, January 8, 1876.
1	52 "	140 grs., 1½ by 1 inch.		1	British Medical Journal, December 7, 1878.
1	69 "	3 stones, 2 of 60 grs., 1 of 36 grs.	1		Lancet, June 5, 1875.
1	17 "	Catheter for nucleus 9 inches long.	1		Philadelphia Medical Times, 1875, p. 106.
1	50 "	Not stated.	1		Dublin Quarterly Journal, vol. lxiv. p. 390, 1877.
1	40 "	" "	1		Dublin Quarterly Journal, vol. lxiv. p. 391, 1877.
1	20 "	" "	Not returned.		St. Bartholomew's Hosp. Rep., vol. xl.
1	20 "	420 grains.	1		Medical Record, vol. x. p. 584.
1	3½ "	Not stated.		1	Medical Record, vol. xii. p. 531.
1	36 "	60 grains.	1		Lancet, June 5, 1875, p. 290.
30			26	3	

* Holmes's System of Surgery, vol. iv. p. 1079.

The cases number 30, 26 of which were cured, 3 died, and 1 was doubtful, —a mortality of 11.5 per cent., not far from that obtained by Gross from his 350 cases. Of the fatal cases, 1, aged fifty-two, died of shock, sixteen hours after the operation; 1, aged three and one-half years, died of pyæmia; the cause of death in the third is not mentioned.

MODIFICATIONS.—The modifications of Allarton's operation consist in the manner of exposing the staff, and in the instruments used for guiding the knife and finger into the bladder. Thus, Thompson reached the staff by cutting from before backward, and Erichsen before passing the finger into the bladder introduced a blunt-pointed director along the groove for the guidance of the digit, the staff not being removed from the viscus until the finger had reached its cavity. Markoe and Little altered the groove of the internal staff, making it broader, in order that it might be more easily reached

FIG. 1416.



Little's director.

with the knife. The latter surgeon also employed a grooved director (Fig. 1416), which was designed as a substitute for the probe of Allarton.

Medio-Lateral Operation.

The median operation has been variously modified. Professor Buchanan, of Glasgow, employs for the purpose a rectangular staff (Fig. 1417), the

FIG. 1417.



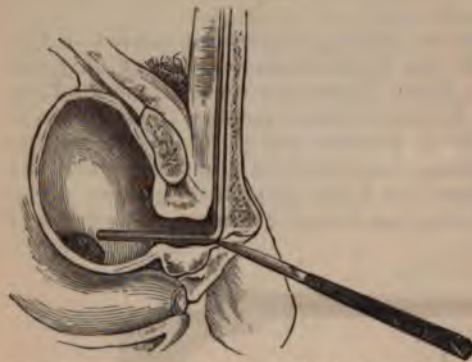
Buchanan's staff.

short limb of the angle being three inches in length, and having on its left side a deep groove. The staff is introduced into the bladder, and, with a finger in the rectum, its angle is adjusted to the apex of the prostate body. The handle is next carried towards the abdomen, making the angle of the staff quite prominent in the perineum. The surgeon now, still keeping the index finger in the rectum, pushes a long narrow-bladed and sharp-pointed knife in front of the anus onward through the perineum, with the blade horizontal and turned towards the left side, until the point enters the groove in the staff, and thence onward until the knife is arrested by the stop at the end of the groove. (Fig. 1418.) The escape of the water through the wound announces that the bladder has been entered, whereupon the knife is withdrawn; in doing this it is made to divide the tissues on the left side of the perineum, in the direction of the tuber ischii, in a curvilinear manner, and to the extent of one inch and a half. The operation is a medio-lateral one, though the membranous part of the urethra is left untouched. The subsequent steps towards the extraction of the calculus are the same as in ordinary lateral lithotomy. The advantages claimed for this operation are rapidity of execution, and diminished risk of hemorrhage and of urinary extravasation into the recto-vesical space. Of 64 patients cut by this plan, 6 died, or 9.3 per cent.

Mr. Henry Lee's method of performing medio-lateral lithotomy consists

in passing a staff into the bladder, the patient being in the usual position for lithotomy; the scrotum is then held well up, and an incision made in the

FIG. 1418.



Incision of the perineal structures and of the prostate on the rectangular staff.

median line of the perineum from before backward, stopping a few lines in front of the anus, from which point the incision is prolonged around the front and left side of the rectum, forming a curved figure. The index finger is next inserted into the wound, and, while the rectum is pressed back, a few touches of the knife will serve to detach the bowel still more from the parts in front. Withdrawing the finger from the wound, it is now introduced into the rectum, and, using it as a guide, the knife, with its back towards the bowel, is carried in the middle line into the groove of the staff through the membranous

part of the urethra; after which it is withdrawn, and another, with a probe point, passed into the groove and pushed onward into the bladder, and a lateral incision of the prostate made from within outward.

Bilateral Lithotomy.

Bilateral lithotomy, believed to have originated with Le Dran, was in 1824 formalized more particularly by Dupuytren. In the United States its most powerful advocates have been Professor Paul Eve, Professor Briggs, of Nashville, Tennessee, and Professor Hughes, of Keokuk, Iowa.

The operation is performed by introducing a staff with a median groove into the bladder, making a semilunar incision with a bistoury across the

FIG. 1419.



Incision in bilateral lithotomy.

perineum about three-quarters of an inch in front of the anus, beginning midway between the anus and the tubercles of the ischii on one side, and terminating at a corresponding point on the opposite side. After the first cut is made the wound is erroneously said to become straight, lying directly across the perineum. (Fig. 1419.) A finger is now introduced into the opening, and the rectum pressed back as the deeper parts are divided until the staff is reached and the membranous urethra laid

open. The scalpel is now laid aside, and, with the nail of the finger resting on the edge of the staff, the beak of the double lithotome caché (Fig. 1420) is conducted into the groove with the concavity of the instrument directed upward. Sliding the lithotome up and down, so as to be sure of its position in the staff, the operator now takes the latter from the assistant into his own

hand, depresses the handle on a level with the pubes, at the same time lowering the lithotome and pushing it onward into the bladder. This accom-

FIG. 1420.



Double lithotome caché.

plished, the staff is to be withdrawn and the lithotome reversed, so that its concavity shall be directed downward, or towards the rectum, when it is to be withdrawn, at the same time expanding the blades by pressing the spring attached to the handle. As the instrument is brought out, both lobes of the prostate are divided in a somewhat crescentic manner. The finger is at once carried through the wound into the bladder and touches the stone, and, having thus learned its location, the operator effects its extraction as in lateral lithotomy, by the forceps. (Fig. 1421.)

In 1836, Civiale introduced a modification of the bilateral method, which he termed *medio-bilateral* lithotomy. A staff with a median groove being passed into the bladder, an incision in the median line of the perineum was made one inch and a half in length, anterior to the anus, and down to the membranous urethra. The latter being then opened, a double lithotome caché, in most respects similar to that of Dupuytren, and closed, was inserted into the groove of the staff and carried onward into the bladder. The blades of the instrument were then expanded, and as it was withdrawn the prostate was divided on either side. The finger then followed the staff into the bladder, when the staff was withdrawn, the forceps introduced, and the calculus removed.

The operation differs from the *bilateral* in the median instead of the semi-curvilinear incision of the perineal structures.

Two other modifications of the bilateral method have been practiced. The first was that of Sir William Fergusson, who, in making the external incisions into the perineum, united to the semi-curvilinear cut of Dupuytren a second in the middle line, with a view of obtaining a large external wound. The other was by Nélaton, who divided the perineum transversely about three-eighths of an inch in front of the anus. This was the *prerectal* method.

Bilateral lithotomy is not likely to become popular either in this country or in Great Britain. The division both of the perineum and of the prostate is entirely too extensive in most instances for the necessities of the operation. In addition to this, both the rectum and the bulb of the corpus spongiosum are more exposed to injury than by the lateral plan. The results, however, of the operation are not less favorable than those obtained by any other method. Professor Briggs, of Nashville, Tennessee, has performed the operation in nine cases without a death. Dr. Campbell, of Augusta, Georgia, records 41 cases of bilateral lithotomy, with 2 deaths, or 1 in 20. Twenty-one of the patients were children, all of whom recovered; and twenty were adults, with two deaths. In 536 cases recorded by Gross there were 41 deaths, or 7.64 per cent.

FIG. 1421.



The three primary or fundamental incisions,—median, lateral, and bilateral.

Recto-Vesical Lithotomy.

Recto-vesical lithotomy, according to Clot Bey, has been practiced time out of mind in Egypt: it was introduced into France by Sanson in 1816, who, before attempting the operation on the living subject, proved it practicable on the cadaver. Barbantini by this method removed a calculus weighing nine and a half ounces. It is rarely performed at the present time.

The operation is executed as follows. A staff with a median groove is carried into the bladder and intrusted to an assistant. The surgeon inserts his left index finger into the rectum with its palmar surface upward. Along the digit a straight-bladed bistoury is carried flatwise until the anterior border of the prostate is reached, when the instrument is turned with the edge of the blade directed upward, and made to penetrate the anterior wall of the intestine and enter the groove of the staff through the membranous urethra, when, by drawing the bistoury backward, the rectum, a few fibres of the levator ani, and the sphincter ani, together with the fascia and integument, are divided to the extent of about one inch in front of the anus. Reversing now the edge of the knife, and placing its point in the groove of the staff, it is pushed onward through the prostate body and the neck of the bladder, and into the vesical triangle. Through this opening the forceps is inserted, and the stone extracted after the withdrawal of the staff. The modifications which have been made of the recto-vesical method are those of Maisonneuve and Bauer. The former opened the bladder without dividing the sphincter ani, and the latter accomplished the same object by exposing the cavity of the rectum with a strong duck-bill speculum, and through it cutting into the bladder behind the prostate, and, consequently, through the trigonum vesicæ without dividing the perineum,—an operation infinitely superior to the old plan. After the removal of the stone the wound is to be closed by silver sutures. Professor Bauer, in 1859, succeeded in curing a case in this manner. A similar success was obtained by Dr. Noyes.

There are, however, certain dangers connected with recto-vesical lithotomy which render it exceedingly improbable that the operation will ever become an established surgical procedure. The evils alluded to are urinary infiltration, inflammation and suppuration of the recto-vesical fascia, injury to the vesiculæ seminales or their ducts, and recto-vesical fistula.

Professor Vacca observes that of seven patients operated on by the above method, four suffered from recto-vesical fistula. Professor Gross speaks of a similar termination in three out of four cases. Dupuytren, who performed the operation six times, lost one-half of his cases from diffuse inflammation of the pelvic fascia.

The mortality which has followed the operation is also calculated to add to its condemnation. Of 83 cases of the operation collected by König,* 67 were cures, 11 recovered with fistula, and 16 died, a mortality of 23.88 per cent. It would be much better, in case of a stone being too large for lateral or bilateral lithotomy, to adopt the supra-pubic plan for its extraction rather than the recto-vesical method.

Supra-Pubic Lithotomy.

The operation of opening the bladder above the pubes has been designated by different names, as the *supra-pubic*, the *high operation*, *cystotomia epigastrica*, and *epicystotomia*. The introduction of this method for the extraction of urinary calculi is attributed to Peter Franco, in 1561, though it had been suggested by Archigenes. In England the operation received very little attention until after it was executed by Proby, when it rose into some notoriety, chiefly through the influence of Douglas, Cheselden, Prye, and others. Cheselden after a time abandoned it for the lateral operation; and notwithstanding it again attained some reputation through the successes of Frère Côme, it generally fell into disuse, unless when called into requisition on account of a

calculus being too large for extraction by other methods. Later, in Paris, it was revived by Souberbielle, receiving the sanction of Carpué, Home, and Scarpa, who were the authors of papers on the subject, as also were Dzondi, Amussat, and Leroy d'Etiolles. In this country the first supra-pubic operation was performed by Professor Gibson, of the University of Pennsylvania, on a patient suffering from calculus, whose prostate was so much enlarged that it was not deemed advisable to do perineal lithotomy. The case proved fatal from urinary infiltration producing peritonitis. The operation was also practiced to some extent by Dr. Carpenter, of Lancaster, Pennsylvania.

OPERATION.—The patient is placed in the recumbent position, with the pelvis at the end of a narrow table and somewhat elevated, and the limbs and feet supported on a chair. The head and shoulders are slightly raised upon a pillow, in order that the abdominal parietes may be relaxed. The hair is next to be shaven from the pubes, and the parts cleansed with alcohol and the sublimate solution. The bladder is well washed out with a four per cent. solution of boracic acid, and then moderately distended with the same,—in the adult, eight or nine ounces of the solution being used. The catheter is now withdrawn, and a gum band placed round the penis to prevent the escape of the fluid. In order to float the bladder and bring it well to the abdominal parietes, a rectal colpeurynter (Fig. 1421*) is passed into the rectum and distended with water (twelve or fourteen ounces being thrown through its tube). An incision must now be made exactly in the linea alba, beginning at the pubes, and extending upward about three and a half inches. The skin and superficial fascia being divided, the aponeurosis of the external oblique is carefully opened in the median line on a director to the extent of two inches.

The non-peritoneal portion of the bladder is now recognized, covered with some loose cellular fatty tissue. This tissue should be sufficiently broken up with a director to expose about one inch of the bladder, not more. With a curved needle a loop of silk thread is next to be passed through the walls of the viscus on

FIG. 1421.*



Rectal colpeurynter.

FIG. 1422.



Opening through the parietes of the abdomen retracted, and the bladder protruded into the opening by the catheter (the latter not necessary).

each side of the denuded part and given to an assistant, who steadies the organ while an opening is made three-quarters of an inch long through its anterior wall. The forceps is immediately introduced, and the stone extracted. The bladder is next closed with catgut sutures, a drainage-tube placed in the supra-pubic space, the abdominal walls brought together by silver or silk threads, and the wound dressed antiseptically. A catheter can be worn for the first twenty-four or thirty-six hours with advantage. The wound closes in from ten days to two weeks. (Fig. 1422.)

The advantages claimed for the supra-pubic operation are its freedom from hemorrhage, the absence of danger to the rectum, neck of the bladder, prostate body, and vesiculæ seminales, and of difficulties arising from stricture of the urethra or deformity of the pelvis, as well as its applicability to cases of very large calculi, which could not be safely extracted by any of the perineal methods. Against these advantages are to be reckoned the danger to the peritoneum, in the hands of a careless operator, and the possibility of rupturing the bladder by displacement and over-distention, an accident which has frequently happened.

The supra-pubic operation for stone in children has its advocates, and does not differ in its execution from the same operation in the adult. Its merits have not as yet been sufficiently tested, however, to warrant any expression of opinion.

Dr. Dulles has collected 493 cases of supra-pubic lithotomy, with 356 recoveries and 137 deaths. Of these, 43 were operated on by American surgeons, 28 of which recovered, 14 died, and in 1 the termination is not noted, a mortality of 32.55 per cent. Adding to this collection 3 later operations, namely, one by Amussat,* one by Fowler,† and one by Hutchinson,‡ we have a total of 496 cases, with 358 recoveries and 138 deaths, a mortality of 27.82 per cent.

Though the fatality appears very great, yet when it is considered that many of the cases were in consequence of the magnitude of the stone deemed unsuited to any other operation, and that in others the supra-pubic plan was adopted after the lateral method had failed, the results are not worse than those obtained from perineal operations. To state it in other words, lateral lithotomy for stones of all sizes is four times more successful than the supra-pubic operation, but when the calculus exceeds two ounces in weight the results are almost as markedly in favor of the latter method. With those between one and two ounces the mortality differs very little in the two operations, and when the calculus was less than one ounce the lateral operation proved by far the more successful. In support of this conclusion a number of cases operated on by the lateral and by the supra-pubic method are contrasted in the following table:

Weight.	LATERAL OPERATION.				SUPRA-PUBIC OPERATION.			
	Recovered.	Died.	Total.	Death-Rate.	Recovered.	Died.	Total.	Death-Rate.
Under 1 ounce.....	482	47	529	8.88 per ct.	11	3	14	21.42 per ct.
1 to 2 ounces.....	101	18	119	15.12 "	17	4	21	19.04 "
2 to 3 ounces.....	19	16	35	45.71 "	10	4	14	28.57 "
3 to 4 ounces.....	4	7	11	63.63 "	13	6	19	31.57 "
4 to 5 ounces.....	2	3	5	60.00 "	9	7	16	43.75 "
5 to 6 ounces.....	2	...	2	100.00 "	7	4	11	36.36 "
6 to 7 ounces.....	...	2	2	100.00 "	1	1	2	50.00 "

With regard to sex, 35 cases of females operated on by the lateral plan are contrasted with 82 in which supra-pubic lithotomy was adopted,—33 recovering and 2 dying, or 5.71 per cent., by the former, and 72 recovering and 10 dying, or 12.19 per cent., by the latter method.

Comparing the different methods practiced for the extraction of stone by incision, we find in 11,342 cases of lateral lithotomy 1220 deaths, a mortality of 10.75 per cent.; in 577 bilateral lithotomies, 43 deaths, a mortality of 7.45 per cent.; in 380 median lithotomies, 35 deaths, a mortality of 9.21 per cent.; in the recto-vesical operation, 83 cases, with 16 deaths, a mortality of 19.27 per cent.; and in the supra-pubic operation, 465 cases, with 135 deaths, a death-rate of 29.03 per cent.

The result of this comparison of methods is in favor of the bilateral operation to the extent of four per cent. of cases. But the numbers compared are so unequal that it is not safe to make the difference a basis for a dogmatic deduction. I doubt not that the highest success in lithotomy would be obtained if the median operation were selected for small calculi, the lateral for stones of medium size, the bilateral for stones above the medium size, and the supra-pubic for such as are of great magnitude, weighing, for example, two or two and a half ounces and upward.

* American Journal of the Medical Sciences, p. 257, January, 1877.

† British Medical Journal, p. 369, September 7, 1878.

‡ Ibid., p. 608, October 19, 1878.

In summing up the subject of dealing with vesical calculi, the following rules may be laid down for the guidance of the practitioner:

1st. All cases of calculus occurring in infancy and childhood should be lithotomized.

2d. All cases occurring in adults in which the stone is soft, and not too large, should be treated by lithotrity.

3d. Even cases of hard stones, consisting chiefly of oxalate of lime (provided the concretion is small), and especially if there is any evidence of the existence of renal disease, should be treated by lithotrity.

4th. All cases not included in the above category are proper subjects for lithotomy. The particular method of the operation is to be determined by the magnitude of the calculus.

5th. Calculous patients suffering from serious structural disease of the kidneys are unsuited for either lithotomy or lithotrity, and should be content with palliative treatment.

Lithotomy in the Female.

In consequence of the dilatability and shortness of the urethra, females are rarely the subjects of vesical calculus. As compared with males, the proportion is about one of the former to twenty-one or twenty-two of the latter. In consequence of the slight depression of the bas-fond of the bladder below the urethra, any concretion which may pass down from the kidneys is readily swept into the latter by the current of the urine, and thus escapes. The middle period of life is that in which females are subject to stone. In some instances the calculi attain an extraordinary size. In two cases I have known the concretion to reach the size of a goose-egg. These calculi are sometimes discharged spontaneously, either through the urethra or by ulceration, into the vagina. A number of examples of stones of large size having passed through the urethra have been recorded by writers. The most remarkable is that given by Molyneux, in which a woman passed a calculus measuring seven inches and six-tenths in length, and five inches and three-quarters at its point of greatest thickness. Somewhat similar cases are given by Heister, Sir Astley Cooper, and others. An instance of a calculus the size of a goose-egg finding its way into the vagina by ulceration came under my own observation. Singularly enough, the opening closed up without leaving a fistula. In another case a large phosphatic calculus passed into the vagina from the dilated ureter by a similar process. This patient had suffered for several years from great vesical distress. The bladder had been repeatedly sounded for stone, without any being detected. Finally, during a paroxysm of tenesmus, and simultaneously with the escape of an enormous concretion into the vagina, the lady expired.

SYMPTOMS.—The signs of calculus in the female are frequent micturition, vesical tenesmus, pain, often extending down the thighs, and, finally, incontinence of urine. As in the male, so in the female, sounding furnishes the only certain evidence of the existence of a calculus. For this purpose, a short steel sound, very slightly curved at its vesical extremity, is to be inserted into the bladder, and carried about in various directions, while the patient is placed on her back at the edge of the bed, with the limbs drawn up and the feet resting on two chairs. The exploration may require to be aided by a finger introduced into the vagina, or, in the case of children, into the rectum, so as to raise dependent portions of the bladder into a favorable position for searching with the sound.

TREATMENT.—There are three methods for the extraction of calculi from the female bladder, namely, by *dilatation*, by *crushing*, and by *incision*.

Dilatation—lithectasy—consists in stretching the urethra, either gradually or rapidly, to an extent sufficient for the introduction of the forceps and the delivery of the stone. This procedure was no doubt suggested by the occasional spontaneous passage of very large calculi through the urethra, some

of which have already been alluded to, and others have been recorded by Middleton, in his treatise on supra-pubic lithotomy, and also by Colot, in his "Traité de l'Opération de la Taille."

The *gradual dilatation* was formerly effected by sponge-tents of increasing sizes. Thomas, in this way, extracted an ear-pick from the bladder. This plan, however, is not regarded with much favor at present, as it has been found to have a tendency to produce urinary incontinence.

Rapid dilatation is to be preferred, and may be accomplished in one or two minutes by passing an instrument (Fig. 1423), closed, into the bladder through the urethra, and then expanding the blades to the required degree.

FIG. 1423.



Instrument for dilating the female urethra.

I have accomplished the purpose perfectly by using, in succession, first the little finger, previously well oiled, then the ring finger, and last the middle finger. By this method I have removed a flat calculus three inches in circumference. For a long time afterwards, however, the patient suffered

from incontinence. The relative frequency of incontinence following slow and rapid dilatation has been examined by Bryant, who found that in 13 cases of slow dilatation 4 were followed by incontinence, while in 15 cases of rapid dilatation not one was followed by this infirmity.*

When a stone exceeds one inch in diameter, it is not advisable to remove it through the urethra. Mr. Bryant, who has given much attention to this subject, fixes the limit at two inches in circumference. The patient, previously etherized, should be placed on the back, across the bed, with her hips resting on its edges, the feet supported on a stool, and the limbs widely separated. As soon as the dilatation has been effected, the forceps are to be introduced, and the stone grasped, taking care to seize it in such a manner that its smallest diameter shall present, when, by a gradual and steady traction, the concretion can be drawn through the urethra.

LITHOTRITY.—When the calculus cannot be safely extracted through the urethra, either on account of its size or from some peculiarity in its shape, *lithotripsy* offers the most certain and effectual method of disposing of the body. The lithotrite is to be introduced into the bladder, and the stone caught and crushed into pieces sufficiently small to admit of their being extracted by the forceps, and by aspiration, at one sitting.

The operation is much easier than in the male, and should always be adopted when it is deemed inadvisable, from the size, density, and roughness of the stone, to resort to extraction through the urethra. The procedure is a very successful one. Of 13 cases analyzed by Bryant, all recovered, though in one incontinence followed the operation.

LITHOTOMY in the female may be performed through the urethra, through the vagina, or above the pubes.

Urethral lithotomy is an exceedingly simple procedure.

Different operators have made their incisions in different directions. Brodie divided the parts directly upward towards the pubes, Colot in the opposite direction, or downward, and Liston preferred a horizontal cut, nicking the urethra on each side, and then dilating. The oblique *unilateral* plan is to be preferred. In the execution of this operation the patient is placed on her back, as in lithotripsy, having been previously etherized. A grooved director (Fig. 1424) is passed through the urethra into the bladder, and its groove turned towards the left side; an incision is made on the instrument with a probe-pointed knife, extending through the urethra into the neck of the bladder, and prolonged outward, and carried downward towards the left tuber ischii to the extent of one inch, observing not to carry the incision too near the ramus of the ischium and thus endanger the internal pudic artery.

* Medico-Chirurgical Transactions, vol. i. p. 123.

In one modification of the bilateral operation, a similar cut is made on the opposite side of the perineum. The bladder being opened, the finger guides

FIG. 1424.



Staff for female urethral lithotomy.

the forceps into the viscus, when the stone, being grasped between the expanded blades of the instrument, is extracted. Formerly it was the practice to allow the incision to heal by open granulation, and the consequence was that incontinence of urine followed the operation in many cases,—nine times in twenty patients, according to the collection of Bryant. At the present time, when such a procedure is demanded, the parts are brought together by deep interrupted silver-wire sutures, and the urine drained away by a Sims catheter. In this way the voluntary retentive power of the neck of the bladder is restored, and incontinence obviated.

Vaginal Lithotomy, in cases of large stones, is the proper operation. Rousset was the first to open the bladder through the vesico-vaginal septum. The operation was sanctioned by Vidal. Since the introduction of the silver thread, and its application to the treatment of vesico-vaginal fistula, *colpo-cystotomia*, as it has been termed, may be regarded as an established surgical operation. It has met the approbation of Dr. Sims and of Dr. Emmett in this country; and in England it has a strong advocate in Dr. Aveling.*

OPERATION.—The patient should be placed across the bed, on her side, with the limbs drawn up and the trunk flexed on the pelvis, or she may, preferably, be placed on the breast, with a low box, which has been covered with a blanket or comfortable, thrust under the abdomen, in order to elevate the hips. The limbs, being bent back, are committed to assistants, one of whom at the same time holds the vagina open by a duck-bill speculum. The surgeon now makes a transverse cut through the anterior wall of the vagina into the bladder, introduces the forceps, and extracts the calculus. The size of the opening must be determined by the magnitude of the stone. An incision one inch in length will be ample for the removal of a calculus the diameter of which is two inches. After the concretion has been extracted, the wound must be closed by the wire and shot suture, and a catheter worn from twelve to fourteen days. In other words, the case must be managed in all respects like one of vesico-vaginal fistula. The operation is attended with little danger to life. In 113 cases, which include 35 by Aveling, 30 by Vidal, and 48 by different American operators, there were 3 deaths. One of these deaths occurred in a patient under the care of Dr. Brinton, when the stone was so large as to necessitate the use of a drill attached to a dental engine before it could be removed.† In another fatal case, under the care of Dr. Fowler,‡ the calculus weighed eight ounces. As the earlier operations of this kind were done before the improvements by Dr. Sims in the branch of gynecological surgery were known, it is reasonable to infer that the large proportion of calculous patients so treated were left with vesico-vaginal fistula.

The *supra-pubic operation*, opening the bladder in the female above the pubes for the removal of a calculus, does not in any way differ from the same operation in the male.

Of 82 cases of this operation in females, 72 recovered, and 10 died, or 12.19 per cent.

* Transactions of the Obstetrical Society, vol. i. p. 1864.

† American Journal of the Medical Sciences, 1878, vol. c. p. 757.

‡ Medical and Surgical Reporter, 1878, vol. xxxviii. p. 500.

The mortality is less in females than in males; 383 operations done in the latter gave 258 recoveries and 125 deaths,—a mortality of 32.63 per cent.

The subject of stone in the female may be summarized thus:

1st. When the stone does not exceed one inch in diameter and has a reasonably regular surface, the proper course to be adopted is rapid dilatation of the urethra and extraction by the forceps.

2d. When the calculus exceeds the above-stated dimensions and is not too hard to be broken by the lithotrite, it should be crushed, and at the same time removed by the forceps and by aspiration.

3d. When too hard and too large to be thus dealt with, the stone should be extracted by opening the vesico-vaginal septum, breaking the concretion, if necessary, before extracting it.

4th. Lateral lithotomy should not be practiced when the stone can be extracted either by dilatation or by the vaginal incision.

5th. Supra-pubic lithotomy should not be resorted to unless under circumstances in which the other operations cannot be performed.

DISEASES OF THE KIDNEYS AND URETERS.

ANOMALIES.—The kidneys present various deviations from the normal standard. These include the *form*, *position*, and *number* of the glands.

Deviations in form are generally associated with those of position. Thus, in displaced kidney the shape is round, quadrangular, or preternaturally flattened. Occasionally the organ appears to be arrested in its development, not passing beyond the lobulated state. The unusual positions taken by the kidney are in front of the vertebral column, above the spleen, or even in the pelvis. Hohl reports a case in which, in consequence of the organ being situated in the last-named position in a parturient female, the delivery of the child was greatly delayed. The kidney could be recognized through the walls of the vagina. Forty years after, a post-mortem examination verified the abnormality. Not unfrequently there exists but a single kidney, and this may occupy the proper position, or it may rest across the spine. When solitary, the size of the organ exceeds considerably that of the normal kidney; it has generally two ureters. The two glands are occasionally found united at their lower (more rarely, at their upper) extremities, forming the horseshoe kidney, and resting in front of the vertebral column.

These anomalies of position appear to affect the left more than the right kidney, and men oftener than women. Weisbach has collected 44 cases of misplaced renal organs, 35 of which concerned the left organ, 8 the right, and in 1 both were displaced. In 29 cases, 20 were men and 9 were women; and of a like number of solitary kidneys collected by Roberts, 22 were males and 6 females, and in 1 the sex was not marked.

Generally these abnormalities are attended with so little inconvenience as rarely to be detected during life; in illustration of which fact not one of the 48 cases collected by Stern appears to have been recognized before death. Sometimes, however, serious evils may follow the irregularity. Of this nature was the case reported by Neufrittle,* in which, by the pressure of a horseshoe kidney on the vena cava, thrombosis of the veins below was produced, and death resulted from interruption to the venous circulation. Köster gives an instance of a woman who died during pregnancy from the effects of the gravid uterus pressing on a large horseshoe kidney.

When only one kidney is present, the organ is predisposed to disease, in consequence, no doubt, of the work which it is compelled to perform.

Floating or Movable Kidneys are frequently observed. The condition is either congenital or acquired, and in almost all cases is met with in females. The right kidney is generally the one affected. Of 96 cases compiled by Ebstein, 82 occurred in females and 14 in males. Of 5 cases which have

* Ziemssen's Cyclopædia of Practical Medicine, vol. xv. p. 771.

come under my own notice, 4 were females and 1 was male. When acquired, the displacement will be likely to happen in the period between thirty and forty years of age, and in persons who are not obese.

CAUSES.—The causes which are concerned in producing the floating kidney are tumors, which, being developed in close proximity, finally encroach upon the renal organs and thrust them from their normal habitat. Disease of the kidneys themselves, as cancer or hydronephrosis, tends also to cause their displacement. The disappearance of the fat in which the organs are imbedded, or looseness of the surrounding connective tissue, also predisposes them to a change of place. Perhaps the most influential of all causes in determining the displacement is violent muscular exertion; and this is rendered more probable by the fact that the floating kidney occurs generally among individuals who belong more particularly to the working-classes: in some cases there seems to be a deficiency in extrinsic pressure, owing to the abdominal walls having been somewhat weakened by a succession of pregnancies.

SYMPTOMS.—Persons who are the subjects of floating kidneys have very different experiences. In some the displacement creates so little discomfort as scarcely to be recognized, and is only discovered accidentally. In other instances the uneasiness is quite considerable, and can be traced to a particular moment when, on making some unusual exertion, something has been felt to leave its usual position and rise to the front of the abdominal cavity; the mobility and weight of the kidney, and the tension of the renal nerves, give rise to fixed or radiating pain, a dragging sensation, and nausea, all of which are aggravated by active movements. Sometimes paroxysms of intense suffering occur, preceded by rigors and faintness, which are supposed by Gilewski to be due to a form of strangulation caused by a twist in the ureter and the vessels of the organ. A careful manual exploration, particularly in patients who are thin, will result in the discovery of a movable tumor near the umbilicus or right hypochondriac region, which in some cases can be recognized as the kidney by its peculiar outline, and possibly by the detection of pulsation in the vessels occupying the hilus of the organ. In connection with these phenomena the lumbar region will exhibit signs of the kidney having left its natural position, being somewhat sunken in, and yielding, when percussed, a resonant in place of the ordinary flat sound.

PROGNOSIS.—Though a tumor of this character becomes the source of much mental disquietude, as well as physical suffering, I am not aware that the movable kidney ever causes death. It may be reduced, or it may contract adhesions to other of the neighboring viscera, and in this way become more stationary.

TREATMENT.—In all cases where the diagnosis has been satisfactorily established, an attempt should be made to restore the kidney to its proper place. To this end, the patient should lie upon his back, with the limbs drawn up and the body bent forward, while the hand of the surgeon presses the organ directly back toward the lumbar region. Should the manipulation prove successful, and the enlargement disappear, a broad compress at least three-quarters of an inch in thickness must be secured to the inner surface of an elastic and accurately-fitting abdominal bandage, which is to be worn around the body. The patient must avoid all violent muscular exertion. No corsets should be worn, nor must the bowels be allowed to become constipated, as all straining efforts conduce to a return of the displacement.

In the event of sudden attacks of pain, with nausea, abdominal tenderness, and other signs of strangulation, it will be necessary to confine the patient to the recumbent position, apply hot fomentations over the abdomen, and administer anodynes, either by the rectum or hypodermically, when the reduction may be attempted with a fair prospect of success.

If the displaced organ cannot be replaced, and the abdominal symptoms culminate in a local peritonitis, it will be best to desist from attempts to restore the gland to its proper place, and to adopt such measures as are cal-

culated to subdue the inflammation of the peritoneum, as the use of leeches, opium, and hot cataplasms. When this is accomplished, a second and perhaps more successful attempt at reduction may be made.

When the displaced organ contracts no moorings and causes much physical distress, the usual appliances having been tried in vain, nephrorrhaphy will become necessary; and in the event of that failing, nephrectomy is the only alternative.

Baum has collected 10 nephrorrhaphies, with 5 cures, 3 good results, 1 failure, and 1 unknown.

Nephritis.

Inflammation of the kidney, as it is witnessed by the surgeon, partakes more of the chronic than of the acute form.

Acute Nephritis.—The causes concerned in developing that form of nephritis which comes properly within the domain of surgery are rarely of idiopathic origin, and I do not propose to treat of Bright's disease, or of desquamative or interstitial nephritis.

Nephritis may follow traumatic causes, as wounds, contusions, strains, and operations on the urethra and bladder, or may result from an irritation or inflammation propagated from portions of the urinary passages more or less remote from the kidney, as in stricture or cystitis, also from the mechanical irritation of renal calculus. Even inflammatory affections of structures which have no other relation to the kidneys than that of contiguity, as disease of the vertebræ, psoas abscess, and hepatic disorders, will extend to the renal organs and cause their inflammation. To these causes may be added cold, a gouty or rheumatic state of the system, and that kind of irritation which results from the operation of medicinal agents which have a tendency to pass through the kidneys, as cantharides, the turpentine, and alcohol.

The seat of the inflammation may be either that part of the organ which is concerned in the secretion of the urine, constituting true nephritis, or those parts which act as receptacles for the urine, as the calices, infundibula, or pelvis.

SYMPTOMS.—The attack is ushered in generally by a chill, followed by pain in the loins, nausea, and vomiting. The pain is usually dull, deep-seated, sometimes lancinating, extending down the thigh, along the ureter or the spermatic cord, attended by retraction of the testicle, is aggravated by pressure, by turning in bed, or by coughing, and is always greater when the patient is standing or sitting than when he is in the recumbent position. The bladder becomes irritable, and there is frequent micturition of scanty, high-colored urine, containing blood, and finally pus. The reaction of the urine is sometimes alkaline, and at other times neutral, and the albumen (which, on the application of heat, is seen to exist, and which appears after the blood) is to be referred to the presence of the latter fluid. With the microscope renal casts can be detected, which contain both blood- and pus-corpuscles. The general system quickly sympathizes with the local inflammation, giving rise to an accelerated circulation, increased temperature, dry tongue, thirst, headache, and nervous restlessness.

TREATMENT.—One of the earliest and most important measures in the treatment of acute nephritis is to secure a free action of the bowels, by administering a few grains of calomel, followed by citrate of magnesia or sulphate of soda. When the pain is severe, wet cups should be applied over the lumbar region, followed by large, hot, emollient poultices. Often a hot bath will give great relief. The use of diuretics is to be avoided. It is just as important to secure rest to the kidneys when inflamed as to an intestine in a similar state: hence liquids are to be used in moderation. The skin must be called to a vicarious office in order to perform the work which it is the special province of the kidneys to do in health. Hence diaphoretics, as Dover's powder, must be given. Should the vomiting prove obstinate, the

effervescing draught or carboic acid water will prove useful. To relieve headache, counter-irritation by mustard sinapisms should be made over the nape of the neck, the epigastric region, on the calves of the legs, and on the ankles. The use of the catheter, unless positively demanded by a distended bladder, is to be carefully avoided, as any irritation of the urinary passages will react injuriously on the renal organs. When acute nephritis has a gouty or a rheumatic origin, the use of iodide of potassium and colchicum will be required, in addition to the remedies already indicated.

Chronic Nephritis may follow the acute form of the disease, or it may begin in so quiet a manner from obstructive causes, as stricture, enlarged prostate, or disease of the bladder, as scarcely to be suspected. It also not unfrequently follows prolonged suppuration, such as occurs in necrosis. The symptoms are quite unlike those which characterize the acute form of the disease. There is no inaugurating chill or rigor, no retraction of the testicles, no acute pain radiating along the cord or down the thighs. The bladder, however, is irritable, requiring to be frequently emptied. The urine is turbid, albuminous, loaded with ammoniaco-magnesian phosphates, alkaline in its reaction, and contains blood, pus, and renal casts. The general health is gradually undermined, the patient losing his appetite, flesh, and strength. These symptoms finally culminate in an irritative or hectic fever, which gradually wears the sufferer out, or the disease may have a more sudden termination by the supervention of complete suppression of the urine, headache, convulsions, coma, and death. The existence of chronic nephritis greatly enhances the danger attending an operation, and hence the importance of examining the urine previous to undertaking any case requiring the use of the knife.

TREATMENT.—The treatment of chronic nephritis is conducted with a view to retard the disease and to palliate the symptoms. A cure is not to be looked for. The body is to be carefully protected against cold. The glandular apparatus of the skin is to be preserved in a moderately active state by warm baths and clothing, the bowels kept in a soluble condition, the quantity of animal food taken by the patient restricted, moderate exercise allowed, all stimulants avoided, and mineral tonics, as the tincture of the chloride of iron, exhibited, with a view to improve the blood and counteract the effects of the imperfectly-performed functions of the renal organs.

Both acute and chronic nephritis are prone to terminate in suppuration.

Pyelitis.—In pyelitis the inflammation which precedes the formation of pus is chiefly confined to the pelvis, infundibula, and calices of the kidney. It rarely exists in the acute form.

CAUSES.—These can generally be referred either to those obstructions which interfere with the free passage of the urine, as stricture, hypertrophy of the prostate, and chronic cystitis, or to the presence of renal calculus. In one case reported by Mosler, in a boy of eighteen years, the obstruction resulted from a neglected phimosis. It is occasionally met with as a sequel of certain of the exanthemata, as scarlatina and small-pox. It may follow pyæmia, hydatids, cancer, and even irritating diuretics.

In the obstructive variety, the mucous membrane of the urinary passages is, in consequence of the backward pressure of the urine, kept in a dilated, congested state, which condition, if long maintained, terminates in an inflammation that gradually creeps upward along the ureters to the pelvis of the kidney. Renal calculus constitutes perhaps the most common cause of pyelitis. Ollivier speaks of blood-clots in the pelvis causing this condition. A concretion once formed in the kidney cannot long exist without provoking inflammation of the lining membrane of the pelvis or its subdivisions. Even if the stone leaves the kidney and becomes arrested in the ureter, if it is long delayed in this duct pyelitis will be likely to follow, as two potent causes of the disease are in operation at the same time, namely, obstructive

and mechanical irritation. Nor is the disease limited to the pelvis. If the exciting cause is not removed within a reasonable length of time, the inflammation extends by continuity of tissue to the parenchyma of the kidney, and the organ becomes the subject of both pyelitis and nephritis.

SYMPTOMS.—An early and prominent symptom of pyelitis is pain in the back. This is particularly severe if the disease depends on the presence of stone. This pain radiates along the ureter towards the bladder, down the inner aspect of the thigh, is felt in the groin, and extends along the course of the spermatic cord to the testicle, causing the retraction of the latter. Tenderness is experienced when pressure is made over the renal region. Attempts have been made to distinguish calculous pyelitis from that arising from other causes, on the ground that in the former there has been an antecedent history of occasional attacks of nephritic colic; but this is a very deceptive test, the last-named symptom may exist independently of stone. Frequent calls to micturate are also among the early signs of the disease, and may be marked a feature that the attention of the physician is directed exclusively to the bladder. The urine is acid and at first scanty; later it becomes more abundant. A microscopic examination of the secretion reveals blood-corpuscles, mucus, and an abundance of renal epithelium of different forms, and, as the affection advances, pus appears disseminated through the urine, imparting to it a hazy or turbid appearance.

As the disease progresses, the patient emaciates, loses strength, and dies, worn out by hectic, or, it may be, in a uræmic convulsion.

PROGNOSIS.—The prognosis in a case of pyelitis will depend in a great measure on the character and duration of the cause which produces it, and on the single or double form of the disease. If it follows a case of stricture, the removal of the latter, so as to allow an unobstructed flow to the urine, will tend to arrest the disease, and may be followed by recovery. If induced by the irritation of a renal concretion, and the stone is not too large to reach the bladder, its escape will form a reasonable ground for believing that the pyelitis will subside. That form of the affection which occurs as a concomitant of certain exanthemata, of pleurisy, or of scurvy, will disappear with the morbid affection which brought the disease into existence. If associated with pyæmia, carbuncle, cancer, tubercle, chronic cystitis, or enlarged prostate, no hope of recovery can be entertained. When pyelitis is double, or affects both kidneys, a fatal termination may be expected.

TREATMENT.—This must be determined by the cause. If stricture of the urethra exists, it must be immediately dilated. If cystitis is present, as also in cases of prostatic hypertrophy, attention must be given to the removal of all residual water.

When the pyelitis is connected with zymotic disease, the kidney difficulty is best treated by attention to its antecedent; and the same is true with regard to all those affections which are instrumental in occasioning the disease. When there is reasonable certainty that the pyelitis has a calculous origin, we should first resort to the use of those agents which possess some solvent power over the stone. When the calculus is composed of uric acid, which may be recognized from the character of the urinary deposit, and which is the most common constituent of calculi, some benefit may be expected from the protracted employment of bicarbonate of potash or phosphate of soda largely diluted, and used to the extent of forty or sixty grains a day. It is within the range of probability that a sufficient amount of the calculus will be dissolved to allow of its escape by the natural passages. If not, nephrolithotomy will be demanded.

Pyelitis may in its course become acute; in which case the pain is intensified, the thirst great, micturition frequent, and blood and pus appear in abundance in the urine. Under such circumstances the treatment will be almost the same as in acute nephritis,—cupping over the loins, hot hip-baths, and warm poultices over the lumbar region, with Dover's powder to alleviate pain and favor the free action of the skin. Alkaline diluents may be allowed in moderate

tion. In case the flow of blood becomes too great, ergot, gallic acid, and opium should be administered. The liquor ferri pernitratis will also be found to exert a controlling influence over renal hemorrhage. In all cases of pyelitis it will be necessary to direct the patient to keep the body well clothed, to avoid exposure in cold, damp weather, to avoid all alcoholic beverages, to use milk largely as an article of diet, and to keep up the tone of the system by the use of the tincture of the chloride of iron, occasionally combining it with some vegetable tonic.

Abscess and sacculation of the kidney are frequent results of both pyelitis and nephritis. The sacculation may be suspected when the discharge of pus is intermittent, diminishing for a time as it collects in one of the pouches, and then overflowing and appearing in large quantities in the urine, forming a dense and light-greenish deposit at the bottom of the vessel.

Suppuration is announced by the development of rigors, followed by fever and sweating, which not uncommonly appear with a regularity similar to that of an intermittent, the exacerbation occurring towards evening. As the disease progresses, the entire organ may become dilated into a number of

FIG. 1425.



Sacculated kidney, the pouches containing numerous calculi.

pouches often filled with calculi, and obliterating all traces of the secretory structure of the kidney. (Fig. 1425.)

Abscess of the Kidney (Pyonephrosis) may be situated in the pelvis of the organ, in its glandular structure, between the latter and the fibrous capsule which incloses the gland, or even entirely external to the organ, in the loose fatty and cellular tissue which surrounds it.

Renal abscess is not always produced by previous disease of the kidney. It may follow injury and disease of the vertebræ and of the spinal marrow. The knife of the pathologist constantly discloses deposits of purulent matter in the kidneys after death from pyæmia. Disseminated or diffused abscesses occur in the kidney from obstructive causes, forcing the urine back into the tubuli recti of the Malpighian cones. The pus is found along the course of the interlobular veins. The return of urine loaded with poisonous products into the vessels occasions the formation of emboli, which, extending into the adjoining vessels, not only lay the foundation of multiple abscesses in the kidney, but are capable of developing a general infection, or pyæmic state of the system at large, but without the participation of other organs in the suppuration. The condition has been particularly investigated by Dr. Dickinson, is sometimes described as the "surgical kidney," and is a very common cause of death after operations on the urinary passages.

Perinephritic Abscess, which includes abscess both in the fibrous capsule of the gland and in the loose cellulo-adipose tissue in which the kidneys are

imbedded, may arise as a consequence of previous kidney disease, from caries of the adjoining vertebræ, from violent sprains or twists of the lumbar muscles, and from disease of the testicle or the cord, the irritation being propagated to the peri-renal connective tissue. This affection, first lucidly described by Rayet, has been carefully studied by Trousseau in his medical clinic, by Feron, Gibney, and Professor Bowditch. Duffin* has analyzed 26 cases of the disease. The three cases published by the last-named surgeon, and believed to be altogether independent of kidney disease, are exceedingly instructive, not only as to extension of the purulent collection, but also as to the necessity of an early opening being made for its evacuation. In all of them the pus had followed the sheath of the psoas muscle, passing beneath one of the arctuated ligaments of the diaphragm, exciting pleurisy, and, after opening into the bronchial air-passages of the lung, was expectorated by the mouth. Similar cases have been reported by Rayet and Lennesrew.† The other directions which abscesses of this nature may take are into the colon or the bladder (Gintract‡ gives an instance of the former), or between the erector spinæ and the abdominal muscles over the lumbar region, in the position of lumbar hernia, or along the psoas and beneath Poupart's ligament to the front of the thigh, or into the pelvis.

SYMPTOMS.—Both renal and perinephritic abscesses are attended with local and constitutional symptoms. At first there is usually experienced in the loin corresponding to the affected organ some uneasiness, which finally culminates in lumbar pain, aggravated on pressure, straining, coughing, turning in bed, or standing. The pain extends along the spermatic cord towards the sacrum, and is often felt in the groin. There is also an acceleration of the circulation, with an elevated temperature, considerable thirst, frequent micturition, and more or less nausea. With the formation of pus are developed rigors, heat, and sweating. If the purulent collection is situated in the kidney, it will probably open into the pelvis, the pus appearing in the urine,—a fact which is calculated to throw much light on the nature of the case. In renal and particularly in perinephritic abscess a distinct and sensitive swelling or tumor will be found in the loin, with œdema of the skin, and probably an emphysematous state of the cellular tissue of the back. This was the condition in two of Trousseau's cases. When the pus tends towards the surface of the lumbar region, flexion of the thigh and the common characteristics of deep-seated abscesses—œdema and redness—will be present.

DIAGNOSIS.—More or less uncertainty must necessarily attend the diagnosis of perinephritic abscess. The diseases with which it may be confounded are lumbar neuralgia and rheumatism, pyelitis, hydronephrosis, cancer, psoas abscess, and lumbar hernia. Neuralgia, however, and rheumatism of the lumbar muscles are not accompanied with chills, fever, or a high temperature, nor is there in these diseases any enlargement or swelling in the loin. To distinguish perinephritic abscess from pyelitis will be a matter of the greatest difficulty. The presence of purulent urine and the absence of lumbar œdema, characteristics of the first-named disease, will form grounds for drawing the distinction. In hydronephrosis, though a tumor may form in the loin, it is painless, while the lumbar swelling in perinephritis is sensitive. Carcinomatous tumors of the kidney are not usually attended with febrile symptoms, a fact which may aid in their differentiation from perinephritic abscess.

Though in both perinephritis and psoas abscess there are flexion of the thigh and lumbar uneasiness, it will be found that in the former extension of the limb creates no uneasiness, and does not produce any incurvation of the lumbar spine. This is not the case in the latter affection. The lumbar tenderness on pressure in perinephritis is also absent in psoas abscess. Lumbar hernia, though exceedingly rare, will, when present, form a tumor over the

* Medical Times and Gazette, 1872, vol. II.

† Sur les Fistules RENO-pulmonaires, Thèse de Paris, 1840: Ziemssen.

‡ L'Union Médicale, 1867, No. 48: Ziemssen.

loin which might be mistaken for a perinephritic abscess. Petit alludes to a case of the kind, the true nature of which, however, was established by its reducibility.

In neuralgia, the accession of the pain is sudden, intermittent, and not aggravated by pressure (characteristics the reverse of those belonging to perinephritis).

The differential diagnosis between purulent pyelitis and perinephritis is predicated on the heavy deposits of pus in the urine, and on the subjective nature of the lumbar symptoms, peculiarities which belong to the former.

TREATMENT.—During the early or acute stage of the nephritis or cellulitis which must necessarily precede the formation of abscess, the treatment will not differ from that described under the head of inflammation of the kidney, namely, cupping, purging, hot hip-baths, and diaphoretics with anodynes, with rest in the recumbent position. When the swelling becomes visible in the loin or elsewhere, it will be proper to make an early evacuation of its contents. By an opening in the loin the kidney may be reached without exposing the peritoneum. For this purpose the tissues should be divided cautiously, in the order of superposition, on a director, until the abscess is nearly reached, when the remaining layer of structure may be punctured, and afterwards the opening freely enlarged, that the pus may escape without obstruction. If the abscess is perinephritic, the prognosis will not be unfavorable. When it is nephritic or pyonephritic, the prospect of recovery will be less certain, and a urinary fistula is likely to follow.

After washing out the cavity well with a sublimate solution, a drainage-tube of large size should be carried to the bottom of the abscess and the wound dressed antiseptically. In cases of extensive damage to the kidney, nephrectomy may become necessary if there is a reasonable probability of the other organs being sound. (See *Nephrectomy*.)

Hydronephrosis.—This disease, the *hydrops renalis* of Walter, was very accurately described by him at the beginning of the present century. It consists in an expansion of the pelvis and the ureter in consequence of an obstruction to the escape of the urine at some point in the course of the urinary tract.

This condition is sometimes congenital, and when so is often found associated with other vices of development, as hare-lip, club-foot, etc. Several cases of the kind have been noticed by Dr. Gervis before the London Obstetrical Society. Fœtal hydronephrosis may attain such dimensions as to interfere seriously with delivery. The extent to which the dilatation takes place will depend on the position of the obstruction. The lower down it is, the more will the ureter participate in the disease.

Among the acquired causes may be enumerated calculous concretions which become impacted in the ureter; inflammatory narrowing of some part of the ureter; pressure from a displaced retroflexed uterus; malignant and other tumors in the pelvis and the abdomen; abscess and morbid growths which encroach on the openings of the ureters; and anomalous emulgent arteries. Hydronephrosis when existing to any great degree is destructive to the kidney. Under the force of the fluid the dilated pelvis, infundibula, and calices of the gland become misshapen and wasted, following which the external part of the organ is destroyed, until finally there remains only an enormously dilated lobulated sac, which may fill the abdomen and extend into the pelvis, contracting in some instances extensive adhesions to the surrounding viscera. In two cases of the disease which I saw, the sac pushed out the abdominal walls immediately below the cartilages of the ribs on the right side, and turned up in front of the corresponding side of the thorax. When the obstruction is low, the ureter may become expanded until its circumference measures three inches. The contents of the sac consist of imperfect urine, or a watery fluid in which uric acid, urates, and oxalate of lime are present. The fluid may be reddish, brown, yellow, or turbid, and

contains muco-pus. Its reaction is usually alkaline. In a few instances a fatty matter has been seen in the sac, also colloid substances. Though in general hydronephrosis affects only one kidney,—the other becoming hypertrophied,—both organs are occasionally involved.

SYMPTOMS.—The early signs of hydronephrosis are so similar in their character to those of many other disturbances of the urinary organs that they possess no diagnostic value. Indeed, when only one kidney is affected, and to a moderate degree, nothing unusual may be observed either by patient or by physician.

When both organs are implicated,—an unusual event,—the embarrassment in the flow of urine will soon attract attention. Not only will the secretion be discharged in small quantities into the bladder, but occasionally when some temporary swelling of the ureter occurs it will be all retained for a time in the dilated chambers of the kidney, or until the pressure resulting from the accumulation is sufficient to force the obstruction to its passage, when it may again suddenly enter the bladder in considerable quantities. Urinary incontinence, vomiting, and a sallow and anxious appearance of the face are common attendants of the disease. It is only, however, when the distention has become of sufficient magnitude to form a considerable tumor that the case begins to assume such distinctness as to make its recognition probable. The swelling appears in the flank and lumbar region, extending forward in an antero-lateral direction. It is fixed and painless, soft and fluctuating to pressure, somewhat irregular or lobulated in its outline, and yields a flat percussion sound. When the obstruction to the passage of the urine is temporarily removed, as when an impacted calculus passes from the ureter into the bladder, the tumor undergoes a sudden diminution in size, enlarging again when another concretion takes the place of the first, as occasionally occurs. The quantity of fluid which one of these sacs contains is sometimes very great. Baum, of Göttingen, reported a case in which there were twenty-five pints present, and Spencer Wells one in which sixteen pints were found.

PROGNOSIS.—Slight cases of hydronephrosis, caused by a temporary delay of a renal calculus in the ureter, terminate favorably. The patient may survive a long time when the disease is unilateral, the sound kidney being capable of performing a compensatory work for the disabled one. In extreme cases of hydronephrosis, affecting either one or both organs, the patient soon dies in a state of stupor or in convulsions from uræmic poisoning, the parenchyma of the kidney being destroyed. In a case which I witnessed, and which terminated fatally, there was a congenital absence of one kidney, the existing one being placed in the median line across the vertebral column.

DIAGNOSIS.—Hydronephrosis resembles in some of its aspects abdominal dropsy, ovarian and hydatid cysts, and suppurative nephritis.

In abdominal dropsy the swelling is not confined to one region, but changes its position with that of the patient. Hydronephrosis is local; position has no effect in changing the situation of the tumor, the loin answering to the swelling remaining flat on percussion, even though the patient turns on the opposite side.

The signs of ovarian and renal cysts are so similar that the distinction is not easily drawn from the rational signs alone. In general it may be said as a basis for the differentiation of the two affections that ovarian tumors are very common as compared with hydronephrosis, and that in cases of the former disease there is generally a steady emaciation in progress, affecting more particularly the neck, breast, and arms. The exploring or the aspirating needle will offer the readiest solution of the diagnostic problem, as the sac of hydronephrosis never contains the thick, ropy fluid of an ovarian cyst, nor does the latter ever yield a fluid resembling in its composition the urine.

Cysts of the broad ligament also resemble ovarian dropsy, but the fluid of the former is clear as spring-water, and when tapped seldom returns.

In cysts of a hydatid origin there is usually a discharge of hydatids with the urine, which will reveal the nature of the malady.

In suppurative nephritis, or pyonephritis, in addition to the presence of pus in the urine, there will be found to have been an antecedent history of chills, fever, and sweating,—phenomena which do not necessarily belong to hydronephrosis.

TREATMENT.—Little is to be expected from therapeutics in hydronephrosis. If the disease is the effect of nephrolithiasis blocking up or obstructing the canal of the ureter, the solvent property of the alkaline remedies will be worth a trial. Kneading or pressure of the tumor with a view to dislodge any obstructing body, as a calculous concretion, has been successfully employed by Roberts in the case of a girl eight years old. Thompson, Hillier, and Fraenkel have tapped these swellings with apparently some advantage; but any operation of this nature should be reserved for cases in which the life of the patient is threatened by the pressure of surrounding organs, as in œdema of the lungs. When there is from this cause an urgent need for operative interference, the aspirating trocar will be the proper instrument, and the point at which it should be introduced into the tumor is in the lumbar region, on the outer edge of the erector spinæ muscle, and close to the border of the last rib. By this course the sac is entered behind the peritoneum. When the tumor bulges in front, of course this rule cannot be adhered to, and the puncture must be made where the prominence is most marked. In addition to puncture, attempts have been made to obliterate the sac by injections of iodine. This was done, it is said, successfully by Billroth and by Schrötter. Maas, following in the lead of Simon, used a double puncture with two trocars, allowing the canulæ with closed stop-cocks to remain; these were removed on the fourth day, after laying open the walls of the abdomen and the sac between; drainage-tubes and carbolic acid dressings were subsequently employed. Death followed, however, a few days after the operation. Last among the measures adopted for the cure of hydronephrosis is nephrotomy, which was performed in one case by Nicaise and Meadows.

Renal Calculus.

Should the saline substances which in a normal condition of the urine are held in a state of solution be precipitated in the form of crystals, there arises a condition which is commonly known as *gravel*.

The formation of gravel or sand is the initial step in the production of stone in the kidney. The aggregation of a few crystals cemented together by a little mucus, or the lesion of a few capillaries by the grit, giving rise to a little clot of blood, constitutes the nucleus for a concretion, which subsequently may be swept into the ureter and excite an attack of nephritic colic, or may be detained in the kidney and by continued accretion attain a bulk which will render its passage to the bladder impossible.

Griesinger states that in Egypt he has seen the eggs of the *distoma hæmatobium* constitute the nucleus for the formation of kidney stone.

These calculi form in different portions of the renal organs,—in the calices, infundibula, pelvis, and even in the straight uriniferous tubes and in the parenchyma.

The concretions may be either single or multiple. In some instances hundreds are observed scattered through the organ, and they vary in size from that of a mustard-seed to that of a walnut. Numerous cases have been reported where the calculus filled the entire pelvis, infundibula, and calices of the kidney. Their surface presents a great variety of appearances. Sometimes they are smooth; sometimes they have facets, the result of friction between one or more concretions; at other times they are rough and tuberculated.

Renal calculi are generally composed of uric acid or of oxalate of lime, most commonly the former. When the concretion is an oxalate, it is usually

solitary, and may have a nucleus consisting of uric acid. Ammoniaco-magnesian concretions are not often seen in the kidney as a primary deposition; and the same may be said of phosphatic calculi.

Renal calculi are quite common in childhood. They are met with in the fetal kidney. Between the ages of fifteen and thirty-five years the tendency to these concretions is markedly decreased; but it recurs after the latter period, and is frequently witnessed in persons of advanced life. Children who suffer from this affection belong, as has been noticed when treating of vesical calculus, to the poorer class of society; but in adults the reverse is true, these concretions being very generally observed among persons of sedentary habits and given to free indulgence both in food and in drink.

The effects of renal concretions on the structure of the kidney are determined by the size, form, character of surface, composition, and age of the calculus. When small, they are likely to be carried into the ureter, and thence pass onward into the bladder, where they either remain, forming the foundation for vesical calculus, or, more fortunately, are expelled from the viscus during urination. Should these stones remain in the pelvis of the kidney, or in one of its compartments, they will eventually, by the addition of new deposits, attain a size so disproportionate to that of the ureter that their expulsion becomes impossible. Such a concretion, particularly when its surface is rough, acts as a local irritant to the mucous membrane lining the pelvis, giving rise first to an inflammatory redness, and even to multiple spots of ecchymosis. This is followed by a catarrhal state of the lining membrane, constituting pyelitis, in which there is poured into the pelvis of the gland first a mucous and later a muco-purulent material. Or the obstruction offered by the concretion to the escape of the urine may dam back the secretion until the dilatation of the pelvis, encroaching more and more on the renal parenchyma, results in its destruction, and in the conversion of the organ into a hydronephritic sac. Even in this extreme condition, where the obstruction has resulted from the impaction of a number of small calculi, the latter may separate and escape through the ureter, and the sacculations may contract to an insignificant size.

In other instances the pyelitis is propagated to the renal tissue, and a suppurative nephritis follows, which results in the destruction of the gland, leaving only the expanded and lobulated sac of the pelvis with its infundibula, and these containing numerous calculous concretions.

During the progress of these extensive structural changes it will sometimes happen that the inflammation of the kidney extends to the surrounding parts, as into the loose cellulo-adipose tissue in which the organ is imbedded, giving rise to perinephritis and extra-renal abscess, into the cavity of which, in the event of the sac rupturing, the concretions may be poured, or an adhesion may take place between the kidney and the colon, and the contents of the sac find their way into the intestine through an ulcerated opening.

SYMPTOMS.—The symptoms which indicate the presence of stone in the kidney are sometimes of a character calculated to lead the physician into error, all the phenomena pointing to the bladder rather than to the kidney. Then, it must have been observed by every surgeon of extensive experience that renal concretions may exist for years without disclosing any characteristic signs. In typical cases of the disease, however, more or less uneasiness and pain are experienced in the lumbar region, particularly when the body has been subjected to any violent movements. The pain is somewhat peculiar, being at times dull, with a sense of weight or pressure deep in the loin, and in other instances severe, cutting, and radiating in different directions along the spermatic cord, down the ureter, or down the thigh. Along with these symptoms the patient often experiences creeps or slight rigors, accompanied with a frequent desire to urinate, the urine being, perhaps, slightly bloody.

When the concretion leaves the pelvis of the kidney and enters the ureter, there will be little difficulty in recognizing the true nature of the disease.

The pain, if it previously existed in the back, is at once transferred to the ureters, where its severity announces an attack of *renal colic*.

Renal Colic comes on under various circumstances. It often follows some unusual and violent movements of the body, as running, jumping, lifting heavy weights, or during paroxysms of coughing; sometimes it comes on during complete repose. The pain from the distention of the urinary tract behind the stone is not restricted to the loins, but shoots down the ureters along the cord to the testicles, accompanied by retraction of the latter, which often enlarge and become supersensitive. It will radiate, indeed, in all directions, around the body to the diaphragm, towards the shoulders, and even down the inside of the arm. The limb on the affected side often becomes numb and stiff, nausea, retching, and vomiting follow, a profuse perspiration breaks out over the surface, the pulse quickens, and the agony sometimes becomes so great that the sufferer is seized with tremblings, and even with convulsions. Women have been known to abort during a paroxysm of kidney colic. During the attack the bladder becomes exceedingly irritable, and the urine is diminished in quantity, and often expelled in drops, scalding the urethra, and mingled with blood, mucus, and pus. When the calculus affects only one of the ureters, the kidney on the other or sound side may become preternaturally active and a copious flow of limpid water follow. It is a rare occurrence for calculi to engage at the same time in the ureters of the two sides; but the anomaly of a single ureter for both kidneys sometimes exists, and this has been blocked by a concretion, preventing in a great measure the passage of any urine to the bladder. The duration of an attack of renal colic varies in different cases. It may not last more than a few minutes, or it may continue, with remissions and exacerbations of pain, for several days. The sudden subsidence of pain usually announces the entrance of the concretion into the bladder; though an attack may terminate by the recession of the concretion.

When the concretion fails to leave the kidney, it continues to increase in size, forming the *renal calculus*, and unless removed causes eventually serious disease of the kidney.

TREATMENT.—The indications in a case of renal colic are the alleviation of pain and the relaxation of the tissues concerned in the passage of the stone. For these ends the surgeon must rely on the use of opiates and the hot hip-bath or general bath. The opiates may be used hypodermically or by the bowel, either as enemas or as suppositories, in combination with the extract of belladonna. When the paroxysms of pain are exceedingly severe, great relief may be obtained from the inhalation of ether. In order that the concretion may be hurried through the ureter more rapidly than would be effected by the peristalsis of its muscular walls, it has been advised to administer largely diuretic remedies, in order to excite a free secretion of urine, which presses against the obstruction from behind. This practice is capable of serious abuse. It is quite proper to administer alkaline drinks, as solutions of citrate or bicarbonate of potash, but their administration should be only to the extent of moderately stimulating the action of the kidneys, so that the *vis a tergo* shall be exerted within the limits of safety. Kneading has also been practiced,—an experiment, to say the least, of doubtful propriety. A flexed position of the body and the limbs, by removing the tension of the ureter, is favorable to the progress of the stone. In prolonged cases of detained calculus, when the belly becomes distended and tender, threatening peritoneal trouble, wet cups can be applied over the loins with advantage.

To prevent the recurrence of these attacks, examination should be made into the prevailing constitution of the urine, so that proper remedies may be administered, and the diet, habits of exercise, etc., regulated, as described under the head of urinary deposits.

Should the calculus remain permanently in the kidney, the case is one for nephrolithotomy.

Renal Hæmaturia is generally the result of external injury, as severe blows, falls, or twists of the lumbar part of the body, or of the mechanical irritation of renal calculus. It may be caused by any inflammatory condition of the kidney; by morbid growths and parasites in the organ; by the action of some poisons, as phosphorus and arsenic; or it may result from the effects of certain diseases on the blood, as smallpox, scurvy, scarlatina, and malarial and typhoid fever. Embolism of the renal vessels sometimes accompanies heart-disease, a condition which will prove influential in determining hemorrhage. In certain parts of South America renal hemorrhage is endemic, the result of parasitic irritation.

It is often a matter of great difficulty to ascertain the source of blood which may appear in the urine. Sometimes the solution of the question is effected by the appearance of the coagula. Thus, when the bleeding is from the pelvis of the kidney, the clots may be moulded so as to assume the form of the calices. When the hemorrhage comes from the parenchyma of the organ, the coagulation takes place within the uriniferous tubules; and when these clots are discharged, they retain the form (cylindrical casts) of the canals from which they are expelled, and may readily be recognized with the microscope. Renal hemorrhage is rarely excessive, and is generally associated with a feeling of some weight, and, possibly, slight pain, in the lumbar region. Large coagula in the urine usually have their origin elsewhere than in the kidneys.

TREATMENT.—The ascertaining of the cause of hæmaturia, and the removal of that cause when possible, are very important preliminaries to the successful treatment of the disease. This cause is often exceedingly obscure; and consequently much of our medication is empirical. There are, however, certain measures which are always appropriate, let the cause be what it may. The patient must be confined on his back. If there is lumbar pain, with a strong pulse, wet cupping over the loins will be demanded, to be followed by the use of astringents and sedatives, as gallic acid, acetate of lead with opium, fluid extract of ergot, aromatic sulphuric acid, and Rockbridge alum water. When the individual is pale, weak, or anæmic, pernitrate of iron, or tincture of the chloride of iron, will prove most useful.

Renal Cysts of different kinds are occasionally met with in the kidneys. Some of these are congenital, others are acquired, and still others arise from parasitic irritation. It is not impossible that in some instances that form of cystic degeneration which appears in adult life may have begun before birth. These cysts vary in size from that of a mustard-seed to that of a pigeon's egg. They occur either solitary, scattered through the parenchyma of the gland, or collected into groups. Their walls are greatly attenuated, or they may even be destitute of walls, the connective tissue of the gland serving as such. They contain uric acid and carbonate of lime, with certain colloid substances, and occasionally cholesterin. They are probably due to dilatation of the uriniferous tubules, in consequence of obstruction.

Another variety of these cysts is met with, which appears to occupy in the main the cortical portion of the kidney. They present a beaded appearance, their walls are thicker than those of the cysts already described, and their origin may be traced both to the urinary tubules and to the Malpighian glomerules. The contents of these cysts are chiefly colloid and pigment matters.

As evidence of the tubular origin of these, at least when they are congenital, it may be mentioned that they are found in the foetus to contain the constituents of the urine. The initial step in their formation is regarded by Virchow as an inflammatory one, or a nephritis, while Koster believes the condition to be due to a defective development of the tubules: this latter view receives some support from the fact that in these congenital cysts there are often other imperfections of structure. In extreme cases of the congenital form of the disease, the mechanical obstruction presented to the rapid

birth of the child is such as to cause death, and may necessitate the operation of embryotomy.

Parasitic Renal Disease is quite uncommon. When present, the parasites occupy both the secretory and the conductory portion of the kidney, occasionally project from the surface of the organ beneath its capsule, and rarely affect simultaneously both glands. They differ both in size and in number, varying in size from a pin's head to a goose-egg, and in number from a single one to hundreds. There are three parasites which are found in the kidney: the *echinococci*, first thoroughly described by Bremser in 1819; the *strongylus gigas*, or palisade worm; and the *distoma hæmatobium* of Bilharz.

The *echinococci* are the most common of renal parasites, and are derived from the *tæniæ* of the dog. Though these cysts are occasionally seen in the human kidney in Great Britain, and on the continent, the disease is said to be most common in South Australia and in Iceland, a large number of the deaths occurring in the last-named place being referred to this cause. The frequency of the disease in these localities is attributable to the number of dogs and their close companionship with man.

The period of life at which this parasitic disease is most common is between the twentieth and fiftieth years. The cysts appear as globular, fluctuating sacs, the contents of which consist of a gelatinous capsule formed of several hyaline laminae, concentrically arranged, which constitute the mother-vesicle of the parasite. In this capsule there is also a clear fluid, floating in which are numerous small vesicles, within which are others of two or three generations. The parasite has a head similar to that of the tape-worm.

SYMPTOMS.—The only sign of the existence of a parasitic or hydatid cyst is the escape of the animal with the urine, which, should there be at the same time a lumbar swelling, would reveal the true nature of the disease. Importance has also been given to what is called the *hydatid fremitus*, particularly noticed by Piorry and by Briançon, which derives its name from a peculiar tremor elicited by making tense the tumor between the fingers of one hand while it is gently percussed with the other.

Sometimes the vesicles break into the pelvis of the kidney, and are expelled in such numbers as to obstruct the urethra and cause some embarrassment to the flow of urine.

TREATMENT.—We are in possession of no medicines which possess any power to expel these parasites, and the only means which offers any hope of relief is the puncturing of the cyst with a trocar after the plan of Simon, or, when it has been once adherent to the abdominal walls, laying the tumor open and treating it with iodine and other irritating liquids. Electro-puncture has also been advised. Certainly we are not at present in possession of a sufficient number of cases to justify any particular line of treatment.

The *strongylus gigas* is derived from the dog, ox, horse, and some other animals, and resembles in appearance the ordinary earth-worm. Its habitat in the human kidney is the pelvis and calices of the organ. Of its mode of entrance nothing is known. The symptoms of its presence are those indicative of the presence of a foreign body, viz., frequent micturition, bloody urine, and lumbar pain. It is destructive to the structure of the kidney.

The *distoma hæmatobium*, first described by Bilharz, is a parasite most generally encountered in hot climates. It is represented as being very common in Egypt, so much so that Griesinger is said to have discovered it 117 times in 363 bodies. The parasite is flattened anteriorly, round posteriorly, and has two suckers. Its ova, which are pointed at one extremity, are supplied with teeth. The embryos, though developed from the ova inside of the urinary organs, soon perish when exposed to the urine. Their presence can be detected only by the discharge of eggs in the urine. These parasites are instrumental in causing serious irritation and structural changes in the pelvis, the ureter, and the bladder, and are often the cause of renal dropsy.

Renal Tuberculosis is ordinarily only a local manifestation of a general tuberculosis, though it may be a primary disease. The tubercles are deposited in both the medullary and the cortical portion of the kidney. In a majority of cases it is probably true that when the granulations are miliary the formation begins in the cortical portion of the kidney along the small arteries which lie between the pyramids of Ferrein, and also upon the surface of the gland. The connective and vascular tissues which occupy the intertubular spaces are found infiltrated with small round cells, which serve to compress or flatten the tubes. The epithelium of the latter becomes granular and fatty, adjoining granulations become confluent and caseous, and in time the entire secretory and receptive or pelvic portions of the organ are invaded and converted into a caseous and purulent mass.

Nor is the deposit limited to the kidney. It sometimes invades the sub-mucous connective tissue of the ureter and bladder, and also involves the structure of the seminal vesicles and the prostate body. There is some slight discrepancy of opinion among pathologists on these neoplasms of the kidney. Some regard those masses of infiltration which possess a cheesy character as merely a retrograde metamorphosis of confluent groups of miliary tubercles, while others believe the cheesy nodules are often only a degeneration of the products of ordinary inflammation. Both conditions, I think, may exist at the same time, but the tubercular takes precedence, and becomes the exciting cause of the inflammatory. When the disease is part of a general tuberculosis, the patient does not survive long; but when its origin is primarily renal, it may have a chronic course.

SYMPTOMS.—The symptoms of renal tuberculosis resemble in so many respects those of pyelitis or of pyelonephritis as to render it difficult to establish a distinction between the two affections.

There is pain in the lumbar region, and later on in the disease a tumor can often be detected in the same region. The urine contains caseous pus and floating debris of disorganized connective tissue filled with small cells in an advanced granular and fatty state. Of course, from the presence of pus, it follows that the urine will be albuminous. There is a difference, however, between the albuminous urine met with in Bright's disease and that which is witnessed in renal tuberculosis. In the former the water is clear, and contains hyaline and other tube-casts, while in the latter the urine is opaque, cloudy, and rarely reveals under the microscope any tube-casts.

The advanced stage of the disease is marked by rigors, emaciation, hectic fever, and exhausting sweats, the patient dying either from uræmic poisoning or from the exhaustion attending the progress of tubercular disease in other organs.

TREATMENT.—The treatment is one simply of palliation,—of opposing the fatal progress of the disease by such agents as contribute to the nutrition of the patient. To this end, cod-liver oil, the preparations of malt, milk, and concentrated broths, will be useful; and as adjuvants, iron, quinine, and fresh air are important remedies. Severe nephralgia and lumbar pain will demand anodynes; and when the tumor appears externally, and collections of pus can be diagnosed by the grooved needle, aspiration of the contents of the swelling will afford temporary relief.

Extirpation of the kidney, even if it could be shown that the disease was unilateral, would in an affection of this nature be entirely valueless.

Renal Carcinoma appears rarely as a primary, generally as a secondary disease. When secondary in its origin, both kidneys are liable to be involved; when primary, the right is most frequently affected. Ebstein, in a collection of 8300 cases of carcinoma, found only three cases of primary cancer of the kidney; and Steiner met with only four cases among 100,000 children in the Children's Hospital at Prague. When children are the subjects of the disease, it will probably appear at some period under the fifth or sixth year; among adults it usually appears after fifty. Renal cancer occurring in ad-

vanced life affects males far more frequently than females; but this relation does not exist in children, as in 15 instances given by Ebstein 8 were boys and 7 were girls. It is in children that tumors of renal cancers attain their greatest bulk.

Carcinoma of the kidney may appear as a medullary cancer or as a scirrhus. The most common form is the hæmatoid carcinoma. The colloid variety is more frequently encountered than the scirrhus. Renal epithelioma is rare. The disease often extends to the pelvis of the kidney and to the ureter, and is sometimes seen as a wide-spread or diffuse deposit over the whole gland, finally obliterating all traces of renal structure; in other instances it appears in nodules disseminated through the organ, and these surmounted by irregular masses of the same character. The parenchyma between the cancerous nodules is frequently sound; often, contiguous to the deposits, it will be found to be congested and slightly infiltrated. In some places it is possible to find a mass or nodule of the disease isolated from the renal tissue by a well-defined capsule. In the hæmatoid variety the most striking anatomical feature of the disease is the great dilatation of the capillaries. When the infiltration is diffused throughout the kidney, the gland will in a great measure retain its form.

Renal cancer begins in the epithelium of the uriniferous tubules. These tubes, when examined microscopically in the diseased district, will be seen to be filled with proliferating epithelial cells; nor is the intervening connective tissue passive. It becomes infiltrated and increased in amount. As in other glandular organs when attacked by cancer, so in renal carcinoma, cysts, hemorrhagic infarctions, and unhealthy purulent collections are developed in the organ as the affection progresses. Renal cancer, unlike tubercular neoplasms, rarely ever attacks the ureter or the bladder.

Kidneys attacked with cancer exhibit a tendency to contract adhesions to surrounding parts, in consequence of the glandular irritation exciting inflammation in the capsule of the organ. Thus, they have been found adherent to the liver, to portions of the ileum, to the duodenum, to the colon, and to the walls of the abdomen.

Secondary deposits follow cancer of the kidney, and these may be established by embolism of the renal vein, the walls of which are sometimes destroyed by the pressure of the surrounding deposit, and its cavity filled with the particles of the latter, which, being detached, are swept along the blood-stream of the lower cava to the heart, and thence to the lungs, where, being arrested in the pulmonary capillaries, they become foci of infection. Secondary deposits also form in the mesenteric and the retro-peritoneal glands.

CAUSES.—The causes of renal cancer are obscure. So far as can be determined from the history of individuals, there are cases of the disease in which no hereditary influence can be discovered to explain its presence. Medical agents which exert an irritating effect on the kidneys have been regarded with suspicion in this connection. Traumatic violence has in several instances been followed by cancer of the kidney; and it is a singular fact that carcinoma of the testicle is not uncommonly succeeded by a like condition of the kidney.

SYMPTOMS.—The two most significant signs of renal cancer are the presence of a tumor and hæmaturia. The former generally appears in the loin, between the crest of the ilium and the last rib, and increases in a direction forward and upward. This enlargement is sometimes painful when pressed upon, at other times painless. Severe paroxysms of pain are often experienced, but they result from the pressure of the growth on contiguous nerves. The uniformity of the presence of a tumor is quite striking: in 52 cases collected by Ebstein it was absent only three times. Hæmaturia is occasionally noticed before any swelling in the flank. It may be quite slight, but in some instances it amounts to a copious hemorrhage, filling the pelvis of the kidney with clots, and even blocking up the ureter. Fibrinous coagula may also be passed

almost completely decolorized. The manner in which this occurs is not difficult of explanation. The blood coagulates in the pelvis of the kidney or in the ureter, and the urine as it passes through washes out the blood-corpuscles which have been entangled in the solidifying fibrin; finally the contraction of the latter, with the presence of the water behind, expels the colorless clot. During the passage of these masses, the pain will often simulate that which accompanies renal colic.

Nothing is to be learned from the urine. In quantity and reaction it does not necessarily differ from the normal secretion. It may, however, contain minute cancer masses, exhibiting the characteristic alveolar structure, which would be calculated to throw much light on the case, and hence the value, in obscure cases of kidney disease, of examining microscopically whatever detritus may appear in the urine.

Jaundice has in a few instances been observed, when the disease was located in the right kidney, in consequence of pressure being exerted on the common bile-duct. When the cava and other abdominal vessels are compressed, or when a thrombosis extends from the emulgent veins into the inferior vena cava, there will occur ascites, enlargement of the superficial veins of the abdomen, and œdema of the lower extremities and the scrotum. It is only towards the termination of the disease, from infection and exhaustion, that febrile symptoms appear.

DIAGNOSIS.—There is confessedly much uncertainty in the diagnosis of renal cancer; indeed, there are no tumors within the abdomen which are so difficult of recognition as those of the kidney, let the disease be what it may.

When the right kidney is implicated, it is liable to be confounded with disease of the liver. In drawing a distinction, the previous history becomes very important. Morbid growths of the liver begin above and descend. The reverse is true of those of renal origin. Besides, in tumors of the kidney, unless adhesions have taken place with the liver or the parietes of the abdomen along the border of the ribs, the fingers of the surgeon, particularly in the recumbent position of the patient, may be insinuated between the margin of the thorax and the enlargement, when connected with the kidney, which is not possible in a hepatic growth. There will also be in affections of the former organ a line of resonance between the enlargement and the lower ribs, and not only so, but, as the colon lies in front of the kidneys, the tympanitic sound of the distended intestine will be brought out by percussion over the tumor, if renal.

When the tumor involves the left kidney, it is liable to be confounded with splenic enlargements. A very eminent surgeon of Philadelphia, distinguished as a diagnostician in abdominal tumors, recently died from what he very confidently believed to be cancer of the spleen, but which upon a post-mortem examination proved to be cancer of the kidney. And here the observations bearing on the differential signs of right renal cancer may be applied to the left.

Ovarian tumors and ascites bear some resemblance to renal enlargements, but in the former the intestines and resonance are usually behind, not in front, as in the latter. Any uncertainty in the diagnosis may be dispelled by the employment of the exploring needle or trocar. Enlargement of the mesenteric glands and renal cancer being both often met with in children, the differentiation of the two is not always an easy task. The fact, however, that in the former the growth is median, and will probably extend equally on both sides, while in the latter in most instances the tumor is unilateral, is not without special significance. In general, a growth which begins on one side of the body in children under five years of age or in persons over sixty, the surface of which is irregular, with lumbar dullness on percussion, and which grows rapidly, presenting unequal resistance at different parts of the surface, and accompanied with hæmaturia, with loss of flesh, and with a cachectic appearance, may be declared to be a carcinoma of the kidney.

TREATMENT.—The treatment is palliative. Bleeding must be controlled by hæmostatics, pain by opiates, and the general condition improved by tonics, good food, and fresh air.

Sarcoma.—The symptoms of sarcoma do not differ from those of carcinoma. The disease occurs generally in the young, and in those advanced in life. I have removed a large sarcomatous kidney in a man seventy-six years of age.

PROGNOSIS.—In both carcinoma and sarcoma the prognosis is unfavorable.

TREATMENT.—Early extirpation of the diseased organ offers the only hope. In regard to sarcoma in children, the operation is contra-indicated.

Operations on the Kidney.

Nephrorrhaphy.—This operation was first performed by Hahn, of Berlin. There are two degrees of displaced kidney: one in which the organ with its capsules slides over the muscle upon which it rests, called *movable kidney*; the other when the kidney carries before it the peritoneum for some distance, giving a kind of mesonephron, and called *floating kidney*.

OPERATION.—Two incisions may be employed, either of which will give a ready approach to the kidney. In one the incision is made parallel to the last rib and one inch below, commencing at the border of the erector spinæ muscles, and continuing forward three or four inches. By the other plan a vertical incision is made along the border of the erector spinæ muscles, extending from one inch below the twelfth rib to the spine of the ilium.

The parts having been thoroughly cleansed, the patient (etherized) is turned over upon the breast, the hips and loins being raised by placing underneath this part of the body a pillow firmly rolled into a cylinder. The operator will encounter the following order of parts: skin, superficial fasciæ, latissimus dorsi, external oblique, internal oblique, and transversalis muscles; the last two attached to the lumbar aponeurosis. Two or three branches from the lumbar or circumflex ilii arteries will require to be caught by hæmostats. On opening the lumbar aponeurosis the peri-renal fat is exposed, which the operator breaks up, thus gaining admission to the kidney, which should be examined by the finger, to ascertain its condition. If sound, the next step consists in mooring it to the loin. This is done in one of three ways: first, by suturing the adipose capsule to the external wound with cat-gut threads; secondly, by passing the stitches through the fibrous capsule of the kidney, and through the external wound; or, thirdly, by including in the stitches both the fibrous capsule and the renal substance. The parts having been well washed out with the sublimate solution, a large drainage-tube is introduced, and the wound loosely packed with iodoform gauze, over which is applied the usual antiseptic dressing. The wound is allowed to heal by granulation.

Nephrotomy.

This operation, which may become necessary in cases of hydronephrosis, pyonephrosis, or hydatid cysts of the kidney, does not differ in its details from that of nephrorrhaphy.

The kidney cyst must be opened with the bistoury, its contents evacuated, and the cavity washed out with the sublimate solution; after which a drainage-tube should be carried into the bottom of the cyst, and the wound lightly packed with the sublimate gauze, and allowed to heal by granulation. Should the kidney be much disorganized by the disease, nephrectomy will be the proper procedure, provided there be no contra-indicating circumstances, as disease of the other kidney, etc.

Bradeur gives 34 lumbar nephrotomies, with 23 recoveries.

Nephrectomy.

The removal of the kidney was first formally executed by Simon, of Heidelberg, in 1869. The way for the operation had been opened by experiments

on animals and the accidental removal of the organ by operators, made long before. There are three ways of reaching the kidney,—viz., by the lumbar, abdominal, and lateral routes.

Lumbar Nephrectomy.—The preparation and position of the patient should be the same as in nephrorrhaphy. In order to obtain sufficient room, two incisions are to be made: one, commencing at the edge of the erector spinae muscles, is carried forward three and a half to four inches, parallel with and one inch below the last rib; the second, which need not be made until the renal region is opened, should be vertical, running down towards the crest of the ilium from the posterior third of the first. Two precautions must be observed,—namely, not to wound the diaphragm in deepening the horizontal wound, and not to open the peritoneum or injure the colon anteriorly. Having reached the perinephritic adipose tissue, the operator proceeds to break it up with the finger, and carefully to enucleate the kidney from its bed. In doing this, no unusual force should be used, for fear of tearing the renal vessels. After the latter have been fairly exposed, a strong aseptic double silk thread should be passed, by means of a stout aneurism-needle, between the ureter and the blood-vessels, and the two tied separately and as far as possible from the kidney. The operation is now completed by dividing, with the scissors, the pedicle and removing the organ. Some advise to encircle all the elements of the pedicle with a double ligature, tying them some distance apart and dividing between. After washing out the cavity thoroughly with a sublimate solution, a large drainage-tube is introduced, and the wound closed by sutures and covered with the usual antiseptic dressings.

Abdominal Nephrectomy consists in opening the cavity of the abdomen through the linea alba, as in an ordinary laparotomy, displacing the intestines, and reaching the kidney in front by opening the posterior parietal peritoneum,—an operation admissible only in case of very large renal growths.

Lateral Nephrectomy.—The abdominal walls are divided one inch external to and parallel with the linea semilunaris, five inches in length practically (Langenbuch's method). Before opening the peritoneum all bleeding points should be secured by catch-forceps or hæmostats. As soon as the cavity of the abdomen is exposed, a flat sponge should be introduced, to keep the intestines out of the way of the wound. The outer layer of descending mesocolon is next divided, taking care not to injure the inner layer, which contains chiefly the vessels. Through the opening thus made the kidney is reached, and with the fingers the fat is detached and the organ separated from all its connections save its ureter and vessels. The vessels and the ureter are to be tied separately with stout silk ligatures. Before dividing the pedicle, if it is seized with a Pean catch-forceps close to the kidney, the wound will be kept free from blood when the division is made. An opening should be made through the loin large enough to admit the passage of a good-sized drainage-tube. After stitching up the wound in the mesocolon and irrigating the cavity with a warm solution of boracic acid, or with warm water previously well boiled, the abdominal wound can be closed as in a laparotomy. The lateral operation is admirably suited for the removal of large renal growths. The ureter when it contains purulent matter, or is ulcerated, should be brought out and fixed in the external wound (Thornton's plan).

Polk did a nephrectomy on a patient with a single kidney. By the abdominal operation this accident would have been avoided.

When it is deemed necessary to remove one kidney, to determine the condition of the other several plans have been advised, as catheterization of the ureters, or compression of the ureters through the rectum,—either by the hand introduced into the rectum or by Davy's rectal lever. The uncertainty attending these plans has operated against their general use. The surgeon

must depend on the absence of uræmic symptoms, the presence of the proper proportion of urea in the urine, and the amount of albumen or pus present.

The causes of death are much the same in all statistics on this subject,—namely, collapse, peritonitis, exhaustion, hemorrhage, anuria, and pyæmia.*

Nephrolithotomy.—Though allusion is made in the works of ancient medical writers to the removal of stones from the kidney, yet there is every reason for believing that the process was largely effected through natural processes, as by the formation of lumbar abscesses. The credit of the present procedure of nephrolithotomy is due to Mr. Henry Morris, of London, who, in 1880, made the first planned operation for the removal of a renal calculus.

The symptoms of stone in the kidney are a dull, dragging pain in the loin, radiating in different directions, bloody urine, vesical irritation, often pus in the urine, nephritic colic, retraction of the testicle, and frequently gastric disturbance. If the stone is smooth, round, and moderately large, it may block up the orifice of the ureter and give rise to hydronephrosis, or, if irregular in form, it may cause suppuration. A calculus may remain many years in the kidney without causing any great inconvenience.

The indications for surgical interference are constant or repeated attacks of colic without the escape of stone, and the existence of considerable pus or blood in the urine, which can be referred to one kidney, there being at the same time reasonable grounds for believing that the other kidney is not diseased.

OPERATION.—As in nephrectomy, there are two methods of operating,—viz., the *abdominal* and the *lumbar*. The lumbar operation should always be selected, unless contra-indicated by some unusual complication.

The instruments necessary are a knife, director, scissors, catch-forceps, artery forceps, an exploring-needle for exploring the kidney, stone forceps, retractors, scoop, needles, catgut, silver wire, and drainage-tube.

The position of the patient, and the line of incision, one inch below and parallel with the twelfth rib, beginning at the outer edge of the erector spinæ muscle and continued for four inches forward and downward, are the same as in the operation of nephrorrhaphy. After the division of the lumbar aponeurosis and the exposure of the peri-renal fat, the adipose tissue is to be broken up with the forceps and fingers, until the kidney is exposed. If any difficulty arises from the space being too contracted for the examination, additional room can be had by nicking the edge of the quadratus lumborum muscle. All hemorrhage being arrested, and the edges of the wound separated by the retractors, the surgeon introduces a finger through the opening in the fatty capsule and explores the surface of the kidney, first its anterior and afterwards its posterior surface, and finally the hilus or pelvis. If no point of hardness is found, he may next pass the delicate exploring-needle into the substance of the organ at different points. If a stone is discovered, the renal tissue is to be scratched through with a director, guided by a finger, until the calculus is uncovered, when its removal is readily effected by either the forceps or the scoop. When the stone lies in the pelvis, the same procedure is to be adopted. Large-branched calculi may require to be broken before removal; the hemorrhage from the kidney soon ceases, or, if bleeding continues, a little tampon of iodoform gauze introduced for a few minutes will arrest the flow. The dressing consists in washing out the cavity with the sublimate solution, introducing a drainage-tube to the bottom of the wound, and bringing the parts together by sutures, followed by the usual anti-septic dressings. The drainage-tube should not be removed too soon, especially if the urine continues to flow through its canal, but may be shortened from time to time as the healing progresses. Urinary fistula has frequently followed the extraction of the stone.†

* The collective statistics of Harris, Bradeur, and Baum, amounting to 398 cases, give a mortality of 24 per cent. There is a difference of 14 per cent. in favor of the lumbar operation.

† Gross and Bradeur make the mortality in nephrolithotomy 9.52 per cent., and Baum 16 per cent.

CHAPTER XXIV.

SURGICAL DISEASES OF WOMEN.

THE diseases peculiar to women and usually requiring surgical treatment—and it is only these which I propose to consider—will be described in the following order:

1. Surgical Diseases of the External Genitalia and the Perineum.
2. Surgical Diseases of the Vagina.
3. Surgical Diseases of the Uterus.
4. Surgical Diseases of the Ovaries.
5. Surgical Diseases of the Urethra.

Surgical Diseases of the External Genitalia.

Adhesion of the Labia.—It is not uncommon to find the opposing surfaces of the labia majora in infants adherent. The condition, though generally congenital, is sometimes an acquired one, and is the result of carelessness on the part of nurses, who fail to maintain the proper cleanliness of the parts, in consequence of which the surfaces become abraded and finally adhere to each other. Generally the union is quite soft. The malformation is usually detected and treated early. Should it be overlooked until girlhood, the bond of connection becomes converted into mature connective tissue, and requires more decided measures for its division than in infancy.

TREATMENT.—The operation of separating the adherent labia is an exceedingly simple one, requiring only that the child be placed on its back on the nurse's knees, the limbs being at the same time bent forward on the body, while the surgeon introduces a probe or a director at the upper angle of the united labia, and, pushing it between the latter, carries it downward through the line of adhesion, which readily gives way before the pressure of the instrument. To prevent re-adhesion, a piece of soft lint or old linen moistened with sweet oil or oxide of zinc ointment must be interposed between the margins of the separated labia, and renewed until the abraded surfaces have cicatrized. Often all that is necessary to effect the separation is merely to pull the labia asunder with the fingers. When this malformation has been overlooked, and the infant allowed to grow into girlhood without surgical interference, the union becomes strong and membranous, and will require to be divided with a bistoury on a grooved director.

Wounds of the Labia are produced by falls astride of a pointed body, by the breaking of a chamber urinal while urinating in the sitting posture, and sometimes by the horn of a vicious animal. These wounds bleed quite freely, in consequence of the vascularity of the parts, and when sufficiently deep to implicate the plexus of veins which surround the vestibule (*pars intermedia*) the hemorrhage may be sufficient to cause death. Sir James Simpson has furnished a number of instances of fatal pudendal hemorrhage from violence done to the labium.

Punctured wounds are frequently followed by considerable diffuse subcutaneous infiltration of blood into the loose connective tissue of the labia.

TREATMENT.—The treatment consists in securing any vessels which may continue to bleed, and uniting the sides of the wound by interrupted sutures, using for the purpose (because of the elasticity of the tissues) fine silk car-

bolized thread, and for the subsequent dressing carbolized oil or laudanum and water.

Should the hemorrhage prove obstinate and general, coming from numerous points, pressure must be made by inserting a compress a short distance into the vagina, placing another on the inside of the labium, and securing the two in place by a T bandage.

Contusions of the Labia may be followed by an abundant ecchymosis or extravasation of blood, forming a considerable swelling. The purple or dark discoloration and the history of an antecedent injury are sufficiently conclusive as to the nature of the swelling.

TREATMENT.—Lotions of lead-water or of dilute alcohol answer a good purpose as discutients. In time even very large accumulations of blood will be absorbed. As in the scalp, so in the labia, the blood in these swellings remains fluid, or, if coagulated, is in very soft, semi-liquid clots.

Pudendal Hæmatocele, or Thrombus, is a swelling consisting of blood, situated in the subcutaneous connective tissue of one of the labia, and when of an aggravated degree will extend even into the cellular tissue around the vagina. Pudendal hæmatocele is not peculiar to the parturient female, but is occasionally witnessed in the non-pregnant. The causes which give rise to these hemorrhages are predisposing and exciting.

Whatever interferes with the free return of the blood from the pudendal plexus of veins will, by causing the distention of their walls, predispose these vessels to rupture. Among these causes may be named pelvic or abdominal tumors, and pregnancy. In this condition, the violent muscular efforts excited in labor, or a slight blow on, or wound of, the labium, will determine the hemorrhage.

The circumstances under which the accident occurs are sufficiently diagnostic of the affection, which has neither the inflammatory history of an abscess, nor the change of location by pressure or position noticed in pudendal hernia.

TREATMENT.—If the swelling is not large, its removal may be safely left to natural processes, lending some assistance by the use of evaporating lotions of lead-water and laudanum, together with gentle pressure by means of a compress and T bandage.

When, on the other hand, the tumor continues to increase in size, or the presence of blood provokes inflammation and abscess, it should be laid open freely, the clots turned out with the finger, the cavity washed out with carbolated water or a solution of permanganate of potash, and the parts supported by a compress and bandage. In the event of the bleeding continuing, the vagina will require to be packed, and the labium compressed, as in cases of obstinate bleeding after wounds.

Abscess of the Labium is by no means uncommon. It occurs both in the married and in the unmarried female, and may follow the violence of sexual intercourse, or may originate in a folliculitis. The disease is recognized by the heat, pain, swelling, and undue redness of the parts.

TREATMENT.—The suppuration is to be favored by the application of warm flaxseed-meal poultices, and the abscess laid open when the fluctuation becomes distinct.

Œdema of the Vulva arises chiefly from two causes, the one non-inflammatory, and the other inflammatory. Mechanical pressure alone may produce it, as may be witnessed during the latter months of pregnancy, when the uterus encroaches on the venous trunks of the body, or when a large ovarian cyst or uterine fibroid offers a similar impediment to the venous current.

Contusions and phlegmonous erysipelas are inflammatory causes of the same condition. The swelling is sometimes very great.

TREATMENT.—When œdema arises from pressure within the abdomen, its cure can be effected only by the removal of the cause. After parturition the swelling disappears: indeed, the tumefaction is often less in the last months of gestation than at an earlier period, as the ascent of the uterus relieves the pelvic veins from pressure. Even when the œdema is due to abdominal or pelvic tumors, it may be relieved spontaneously by the morbid growth changing its position. Should the swelling become very large, threatening disorganization, two or three punctures will remove the extreme distention by draining away the serum. When the œdema is the result of phlegmonous erysipelas, and the infiltration endangers the vitality of the labium, a free incision becomes necessary.

Gangrene of the Vulva is preceded by a tumefied purple appearance of the labia, attended by symptoms of grave constitutional disturbance. One or more vesicles of a gray color make their appearance in the vulva. These soon become filled with bloody serum, and are surrounded by a zone of indurated tissue; the vesicles run rapidly into ulceration, and finally mortification, which, unless promptly arrested, ends in the death of the patient.

The disease is dependent on a vitiated and depraved state of the blood, and is prone to attack women of dissolute lives, or pale, puerperal, anæmic females. Children are not exempt from the disease, and when it occurs in this class of patients it is a sequel to certain exanthemata, as scarlet fever or measles, and diphtheria. The disease has in some instances assumed the form of an epidemic.

TREATMENT.—As in hospital ulceration or gangrene, so in gangrenous vulvitis, an apartment well ventilated and the strictest attention to cleanliness are of the first importance in treatment. The local extension of the destructive process must be promptly arrested by a potent caustic, such as bromine or the acid nitrate of mercury. The severity of these applications requires the employment of an anæsthetic. After the caustic has been thoroughly applied, the parts must be covered with warm flaxseed-meal poultices, any loose or detached portions of the sloughs should be removed, and the remaining part well disinfected by washes of permanganate of potash. The general strength is to be sustained by the very best nourishment which the patient can take, aided by stimulants and tonics, quinine, and tincture of iron.

Inflammation of the Vulvo-Vaginal Glands.—These conglomerate glands, which lie between two layers of the ischio-pubic fascia, having each a duct about half an inch in length, opening on each side of the entrance of the vagina, become the seat of inflammation, characterized by heat, redness, itching, and tenderness of the vulva. The inflamed gland forms a circumscribed mass, which may be felt by introducing a finger into the vagina and pressing outward towards the ramus of the ischium.

The disease, unless early recognized and promptly treated by the local abstraction of blood, a purge, and lotions of warm lead-water and laudanum, is liable to terminate in suppuration, or in the formation of a cyst by the occlusion of the duct.

Abscess.—When suppuration follows, it may be recognized by the ordinary signs of precedent inflammation and by fluctuation. The pus is sometimes discharged through the excretory duct of the gland, or it may be conducted forward between the layers of the ischio-pubic fascia, and escape on the surface, at a point between the lesser and greater labia.

TREATMENT.—When antiphlogistic measures fail to secure the resolution of the inflammation, the suppuration should be hastened by warm fomentations or poultices, and the surgeon must make an opening into the collection at any place where it exhibits a disposition to point.

Cysts.—When cystic degeneration of the glands of Bartholini or of their excretory ducts occurs, the only plan of effecting a permanent cure is either

to excise the body in its entirety, or to destroy it through suppuration and granulation.

Excision requires that a vertical incision be made between the junction of the two labia of the affected side. A little dissection, with one finger in the vagina to press the gland towards the surface, will render its removal quite easy. Rarely will more than a single vessel (the transverse perineal artery) require the ligature.

Incision consists in laying the sac open by a cut similar to that made for the excision of the gland, turning out the clear, syrup-like contents, and packing the cavity with a little carbolized lint, until it becomes closed by granulation. Either plan will prove effectual. Cauterization of the sac, after its cavity has been exposed, has also been recommended; but it will be more likely to fail than when the stuffing method is adopted.

Follicular Disease of the Vulva is an inflammation of the solitary glands which are scattered over the vulva. There are two varieties of glandular bodies occupying the labia and other parts of the vulva,—the sebaceous and the muciparous glands. The disease may involve one or both of these. The symptoms of this folliculitis are heat, redness, burning, and itching, with infiltration of the connective tissue of the follicle (Fig. 1426), and the formation of vesicles containing a thick, ropy fluid when the muciparous glands are involved, or a little cheesy or purulent matter when the disease is in the sebaceous glands.

Follicular vulvitis sometimes appears during gestation, and may also arise from indifference to cleanliness, also from the irritation of the mucous surface of the vulva by leucorrhœal discharges, or by those coming from carcinoma of the uterus. The disease assumes occasionally a chronic form, and extends into the urethra.

TREATMENT.—The remedies best adapted to a case of follicular vulvitis are washes of carbolated water, laudanum and water, tar-waters, or warm chamomile tea, followed by light flax-seed-meal or slippery-elm poultices. Penciling the parts with a weak solution of nitrate of silver (three or four grains to the ounce of distilled water) also exerts a salutary influence over the disease; and the same is true of dilute hydrocyanic acid and lime-water (equal parts), which can be applied by moistening strips of old linen with the liquid and placing them over the parts. The disease when developed during pregnancy will sometimes resist all remedial applications, and subside spontaneously after parturition.

Hypertrophy of the Labia.—The labia majora are most frequently the seat of hypertrophy. The enlargement is sometimes unilateral, at other times bilateral. The growth in simple hypertrophy rarely exceeds in size that of an orange. It is oblong in figure, the surface being either ridged or wartlike (Fig. 1427), and, histologically, consists of an increase in the normal constituents of the part.

The causes which are chiefly instrumental in determining hypertrophy

FIG. 1426.



Follicular disease of the vulva.

of the labia are venereal. As the labia increase in size the mucous surfaces often become ulcerated from attrition, and are covered by exceedingly offensive discharges.

FIG. 1427.



Hypertrophied labia.

pendulus by transfixing its base with a sufficient number of pins, around which ligatures can be tied to command the bleeding; or the hemorrhage may be arrested by the use of the thermo-cautery.

Elephantiasis is rarely seen in this country. It is not limited to the labia majora, but includes the lesser labia and the clitoris, and does not differ in structure or in treatment from the same disease elsewhere.

Varicose Veins.—The venous plexus which lies beneath the labia (*pars intermedia*) is occasionally the seat of a varicose enlargement, forming a considerable mass of dilated and tortuous trunks, the walls of which are some-

FIG. 1428.



Varicose veins of the labium.

times quite thin, giving to the swelling a blue color; or they may be slightly altered in their structure. During gestation these varicose veins are much increased in size from the mechanical obstruction to the intra-pelvic venous circulation, and become the source of uneasiness to the patient, who is led to anticipate rupture and hemorrhage. (Fig. 1428.) The disease occurs both in the young and in the middle-aged female, but rarely under any other condition than that associated with pregnancy, though occasionally cases have been witnessed in which the varicosity of the plexus was quite independent of the gravid uterus, but connected with a like state of the veins of the lower extremities.

TREATMENT.—Operative measures are never demanded unless in the event

The remedy is excision: this should be executed by reflecting a flap of skin, and also one of mucous membrane, after which the intermediate dense mass of fibrous tissue constituting chiefly the hypertrophy should be removed, and the flaps stitched together by a few interrupted sutures, the wound being dressed afterwards with a water or carbolated oil dressing.

When the skin has undergone much structural alteration, being rugose or warty, it should be sacrificed in common with the other portions of the labium; and as the latter, when thus altered, contains a large number of small vessels, from which much blood may be lost, it is best to precede the removal of the

During gestation these varicose veins are much increased in size from the mechanical obstruction to the intra-pelvic venous circulation, and become the source of uneasiness to the patient, who is led to anticipate rupture and hemorrhage. (Fig. 1428.) The disease occurs both in the young and in the middle-aged female, but rarely under any other condition than that associated with pregnancy, though occasionally cases have been witnessed

of rupture, which might follow the pressure of the foetal head as it emerges from the pelvis, when the ligature would be required. After parturition, the cause of the distention being in a great measure removed, the vessels resume their normal size, and cause no further inconvenience. In one case of a young primipara who consulted me on account of a large spongy bunch of varicose veins of the right labium, the disease did not recur in the gestations which followed the birth of the first child. Some palliation may be obtained, when the enlargement becomes troublesome, by enforcing rest in the recumbent position and preventing fecal accumulation in the lower bowel.

Warts are quite common on the vulva. They appear frequently in great numbers, have a pale red color, and are sometimes so closely grouped together as to form cauliflower-looking excrescences. These papillomatous growths often extend up into the vagina, and have almost invariably a gonorrhœal or syphilitic origin. A form of papilloma has been described by Emmett under the name of oozing tumor of the labium. (Fig. 1429.)

TREATMENT.—This consists in touching the excrescences from time to time with the acid nitrate of mercury or chromic acid, and packing the vulva with lint, frequently renewed, so as to absorb all moisture, the presence of which favors the growth of these bodies. In obstinate cases in which caustics do not answer the purpose, these warts can be clipped off, and the surface touched with a crayon of nitrate of silver or nitric acid. When the bleeding continues for any time, the raw surface should be covered with the persulphate of iron, and a compress bound upon the vulva for eight or ten hours.

FIG. 1429.



Papilloma of the labium.

Epithelioma of the Labium is quite a common affection, and oftener seen in females after fifty years of age than at any other period of life. It begins much in the same manner as does the same disease when seated in the lower lip, either as a fissure or crack, or as a wart-like excrescence, situated at the junction of the skin and mucous membrane of the labium, either on the side of these cutaneo-mucous folds or at their superior commissure. (Fig. 1430.) The ulceration is irregular, with undermined borders, and with more or less surrounding infiltration or induration; the pain is sharp and lancinating, and the discharges are unhealthy, mixed with blood, and possessed of an offensive odor, with a disposition, as the destructive process advances, to implicate the lymphatic glands in nearest relation to the disease (as the inguinal), and also with a tendency to profuse bleedings. Epithelioma may be confounded with a syphilitic sore. A careful inquiry into the history of the case will prevent an error of this kind. It may also be observed that the venereal ulcer never gives rise to the severe pain of cancer, and yields readily to internal treatment.

TREATMENT.—The only hope of removing the disease is in an early excision, before the affection has extended too much to allow the knife to include in

FIG. 1430.



Epithelioma of the labium.

the operation healthy tissue. When the glands have become contaminated, operative measures will prove valueless, except in the way of palliation.

Tumors of the Vulva.

The morbid growths which are commonly encountered in this region are fibro-myomatous, adipose, sebaceous, cystic, myxomatous, carcinomatous, and, in rare instances, neuromatous.

Fibrous Tumors of the Vulva are deeply imbedded in the substance of the labium when primarily originating in the latter: they are movable, somewhat pyriform in shape, and encapsulated,—peculiarities which will prevent their being confounded with simple hypertrophy of the labium. It is, however, in hot climates that these growths are seen most frequently and oftenest attain considerable magnitude. Though the preponderating element of these neoplasms is connective tissue in different stages of development, they frequently—particularly when of long duration—contain cavities which are filled with different kinds of fluids.

TREATMENT.—Excision alone will remove the disease. In performing this operation, the surgeon must remember that the growth may send a prolongation upward between the vagina and the ramus of the ischium into the pelvis; or it may have originated within the latter, and have involved the labium secondarily. In either event, the portion extending within the pelvis, when it cannot safely be exposed to the full extent, should be ligated and cut off below.

Adipose Growths I have never seen in the structure of the labium, though they have been observed by others. They can be easily recognized by their soft, doughy, inelastic feel, and by the fissures or dimples which appear on compression, marking the dip of the interlobular connective tissue.

Excision is the remedy.

Sebaceous Tumors are almost as rare as the adipose. I can recall but a single case of the kind. It was about the size and the shape of a marble, and moved freely under the finger. The treatment is excision.

Cystic Growths may develop in the labium and grow to a large size. They have sometimes a traumatic origin, their beginning being around a little clot of extravasated blood, or they may arise from one of the mucous glands. (Fig. 1431.) The wall of the cyst is formed out of the condensed cellular

FIG. 1431.



Cyst of the labium.

tissue of the labium, and contains a clear serum, or, when formed from a mucous gland, a ropy, straw-colored fluid. These tumors are either spherical or oblong in shape, and possess considerable elasticity. The grooved needle can be resorted to when any doubt exists as to the nature of the enlargement. They are most satisfactorily treated by excision, which, to be effectual, must include the cyst-wall.

Myxomatous Tumors are very rare in the labium, and require excision for their cure. Encephaloid, scirrhus, and sarcomatous tumors of the labia are of rare occurrence. The first two are generally extensions of the disease from other portions of the genital tract, as the vagina, the uterus, or the clitoris.

Clitoris.—Wounds of the clitoris are exceedingly rare. When an accident of this nature takes place, the hemorrhage is profuse, and has been known to terminate fatally. The bleeding can be most satisfactorily controlled by a pin and twisted ligature.

FIG. 1432.



Hypertrophy of the clitoris.

Hypertrophy of the Clitoris is quite common in Eastern countries, where, indeed, in consequence of the early development of the sexual apparatus, the normal size of the organ is greater than in more temperate latitudes.

It is thought by some that the growth of the clitoris is often provoked by systematic excitation of the parts from handling or from venereal excess; but there is no evidence that such is the case. (Fig. 1432.) Women of the town and masturbators do not differ materially in this respect from those whose lives are pure. In cases of hyper-

trophy of the clitoris the nymphæ often partake of the enlargement, the tumor then having a pedunculated form.

TREATMENT.—When the hypertrophy has attained a large size it will require to be removed, an operation which is most safely accomplished by pushing a pin through the pedicle of the mass and surrounding it with a thread before cutting away the growth. In this way bleeding can be prevented.

Clitoridectomy has been performed for the cure of epilepsy. The number of successful cases which have been recorded from time to time amply justify this procedure, unless, as has been proposed by White, of Buffalo, the division of the pubic nerves which supply the organ should be found to answer the same purpose as amputation, in which event neurotomy ought to be substituted.

Pruritus of the Vulva, though sometimes a true neurosis, is in a large proportion of instances secondary to morbid conditions located elsewhere, causing an excessive irritability of the nerves distributed to the vulva.

SYMPTOMS.—The earliest intimations of the disease consist in a feeling of irritation in the parts, with some heat and a desire to scratch. These symptoms may appear only when the patient has been somewhat overheated, or they may arise at certain times in the day, or on retiring to bed at night. In aggravated cases of pruritus the burning and itching become so intolerable, and the impulse to scratch so irresistible, that the mucous surface of the vulva becomes inflamed and abraded. When the paroxysms are nocturnal, the patient is entirely deprived of sleep and rendered miserable through the day. The disease is not always confined to the external genitalia, sometimes extending into the vagina and to the inside of the thighs and over the abdomen, frequently accompanied with an eczematous eruption. So distressing does this affection sometimes become that I have seen women, in a frenzy of suffering, lose all sense of modesty, and, while detailing their symptoms, commence vigorously to scratch. Some, in despair, become melancholy, and even exhibit suicidal tendencies.

CAUSES.—The causes of pruritus are numerous. Among them may be mentioned discharges from the uterus, from the vagina, or from the urethra, indifference to personal cleanliness, pregnancy, urinary incontinence, inflammation of the vulva or of the vagina, diabetes, sexual excess, onanism, parasites, and a depressed state of the system at large. Among those named, leucorrhœa is by far the most common.

TREATMENT.—The first object of the practitioner should be to discover the cause on which the pruritus depends, and as far as possible effect its removal. Unless this is done, no treatment can be followed by permanent benefit. In the mean while, remedies calculated to alleviate the pruritus should be used. That these may exert their proper influence, the utmost attention to cleanliness must be observed, for which purpose douches and ablutions with warm water two or three times a day are required; after which various medicated substances can be used to allay the irritation and hyperæsthesia, as solutions of borax, of acetate of lead or acetate of zinc, decoctions of chamomile flowers, infusion of tobacco, tar-water, and water impregnated with carbolic acid. Of these there are three which prove most efficacious in subduing the severe itching, ranking in point of value much in the order in which they are named,—carbolic acid and water (one drachm of the acid to one pint of water), infusion of tobacco, and tar-water. The bichloride of mercury also enjoys a deserved popularity as a wash. Fifteen or twenty grains of the salt dissolved in four ounces of water, either with or without the addition of a little laudanum, may be applied directly to the parts.

When the disease has been induced by parasitic irritation, for example, that incident to the presence of the pediculus pubis or the acarus scabiei, mercurial ointment for the first and sulphur ointment for the second will answer the best purpose.

The late Professor Charles D. Meigs discovered short, stiff hairs growing from the mucous surfaces of the labia, which from their misplaced position caused considerable local irritation. When seeking for the causes of pruritus, the possibility of the presence of these hairs should not be overlooked, and if they are found they should be destroyed by depilatory agents.

Hymen.—The hymen is liable to be involved in inflammatory affections of the vulva, and may become the seat of syphilitic ulceration. Though generally a delicate structure and easily lacerable, it sometimes possesses sufficient strength to offer an insuperable obstacle to successful intercourse. A case of this character came under my observation in which the membrane had resisted for several months every advance of the lady's husband, and required to be divided with the bistoury.

Vaginismus, though recognized by Dupuytren, Michon, Burns, Simpson, and Scanzoni, has been more particularly described by Sims.

This neurosis consists in a supersensitive state of the nerves at the orifice of the vagina, producing a rigid contraction of the sphincter vaginae muscle, and rendering the parts so extremely sensitive and painful to the slightest touch as to make all attempts at intercourse impracticable.

This affection may be idiopathic or symptomatic. When of the former nature, it will be found in females of a highly nervous, sometimes hysterical organization. When vaginismus is secondary to local irritation elsewhere, the cause may be traced to an irritable carbuncle, or to an ulcer on the posterior fourchette, as was the case in one of my own patients. Scanzoni discovered that in 25 cases the cause could be traced to uterine disease, as dysmenorrhœa, amenorrhœa, metritis, etc. Dr. Neftel, of New York, traced the disease in four cases of vaginismus to lead-poisoning. Females who labor under this affection suffer exceedingly in all attempts at coition, are thrown sometimes into violent nervous paroxysms of trembling, and are usually sterile.

There can be no difficulty in recognizing this condition. The slightest touch of the orifice of the vagina with the finger, or even with a feather, will cause the patient to start and to cry out with pain.

TREATMENT.—A careful examination should be made in every case of vaginismus before adopting any treatment, to see if a sufficient local cause exists in the condition of the uterus, vagina, or rectum, and, if any such is discovered, measures must be instituted for its removal. When none can be detected, there are two courses open to the surgeon,—the one by *anæsthesia with dilatation*, and the other by *incision*. I was at one time favorable to the use of the knife, but after a larger experience in the management of this affection I believe the cases which require incision are very few indeed. Professor Penrose, who has treated many cases of this affection, informs me that he never resorts to the knife; and the testimony of Dr. Wilson, of this city, is to the same effect.

Anæsthesia and dilatation.—The patient being etherized, placed on her back, and brought with the hips to the edge of the bed and the limbs supported, the surgeon introduces the index fingers back to back, well oiled, into the vagina, and then forcibly stretches its orifice to the fullest extent, maintaining the dilatation for three or four minutes, thus paralyzing the sphincter of the ostium. A moderate-sized rubber speculum, three inches in length, and covered by a shield of old linen or lint well smeared over with an ointment of belladonna, is now introduced into the vagina, and retained in place for twenty-four hours with a T bandage; after which it can be removed, and a one-grain vaginal suppository of extract of belladonna introduced. For eight or ten consecutive days it will be necessary to insert this speculum and allow it to remain for five or six hours, in order to maintain the advantage gained and to obtund still further the sensibility of the parts. During this treatment the patient should remain quiet in bed, use once a day vaginal

douches of warm chamomile tea, or of plain warm water with a little laudanum added, and live separate from her husband.

Incision.—The operation practiced by Dr. Sims, and which would be proper in a case where dilatation had failed to afford relief, is performed in the following manner. The patient, being etherized, is placed in the lithotomy position, and the remains of the hymen are clipped away by the curved scissors. The fourchette is now placed on the stretch by the middle and index fingers of one hand being introduced into the vagina and separated, when with the other hand the operator by means of a bistoury makes a deep incision, commencing a little on the right of the median line, and terminating at the perineal raphé. A similar cut is made on the opposite side, the two uniting at the raphé. A conical glass tube or dilator, closed at one extremity, and measuring in diameter one inch to one inch and a half, is inserted into the vagina, where it is retained by a T bandage for two or three hours, morning and evening, according as it may be borne by the patient. This is to be kept up for three or four weeks, or until all inordinate sensibility disappears.

In reference to incision, I may say that two cuts three-eighths to half an inch in extent, and carried obliquely outward on either side from the median line, or even a single cut the same length in the line of the perineal raphé, if followed by forcible stretching, will answer quite as well as the incisions described above.

There are cases of vaginismus in which the supersensitive and rigidly contracted condition of the ostium vaginae is symptomatic of an irritable state of the general nervous system, and which require, in order to render local treatment successful, the use of constitutional remedies, as iron, quinine, strychnia, arsenic, valerian, sea-bathing, and a life much in the open air.

Lacerations of the Perineum.

Rupture of the perineum is not an uncommon accident. It generally occurs during first labors. In ninety per cent. of the cases which have come under my own observation it occurred in primiparae. When we take into account the enormous distention to which the foetal head subjects the normal perineum, not exceeding one inch and a half in length, and the consequent thinning of the tissues which compose it during the final stage of labor, it is no matter of surprise that these cases of laceration are so often witnessed.

CAUSES.—The causes of ruptured perineum may be considered under three heads: *first*, those connected with the mother; *second*, those belonging to the child; and, *third*, those referable to the use of instruments. Under the first may be mentioned powerful uterine contractions, suddenly extruding the foetus before the resistance of the parts has been sufficiently overcome; deficiency in the tone of the muscular components of the perineum, rendering it incapable of reacting against the pressure of the head or other presenting part of the child; and sudden recurrence of suspended uterine contractions at the moment when the tissues are stretched to the utmost limit. In such an event the tear occurs either by the perineal muscles contracting powerfully in order to meet the emergency, or from their inability, in consequence of long over-distention, to contract at all. Nor must we ignore the form of the perineum. There are congenital peculiarities which exert an influence on the mechanism of labor, greatly complicating the process, as, for instance, a redundancy of perineal tissues with a straight sacrum. This vice of organization favors the direct protrusion of the presenting part, instead of deflecting it in the axis of the proper curve. Under this head may also be noticed a preternatural narrowing of the pubic arch, interfering with the movement of extension, and thus rendering it necessary that the stretching of the perineum should be inordinately great to admit of the passage of the head.

Under the second head among the most conspicuous causes of laceration are unusual size of the foetal head and unusual breadth of the foetal shoulders or hips, requiring for their extrusion an excessive extension of the vaginal outlet. It is possible for the head to escape without harm to the perineum, and yet for the latter to be torn by the shoulders which follow.

Instruments constitute the third cause of the accident, and in unskillful hands are capable of doing incalculable mischief. If a child is pulled through the maternal passages by the forceps without regard to the curves of the pelvis, or if the instrument is used regardless of the principle of the lever, or if the accoucheur allows himself to be surprised by the sudden expulsion of the head and forceps together, there is no doubt that a rupture will be likely to happen. In wise and practiced hands, however, I regard instruments as among the most valued resources of the obstetric art, and capable of preventing the very damage which they are frequently charged with producing.

Besides the causes which are immediately connected with parturition, laceration of the perineum may be occasioned by falls upon pointed bodies, or by the extraction of large tumors through the vagina. I have seen this occur during the removal of an enormous fibroid.

VARIETIES.—There are four degrees of lacerated perineum: *first*, where the laceration extends from the posterior commissure, stopping short of the perineal centre; *second*, where the laceration reaches the verge of the anus, including the skin and subcutaneous cellular tissue, but not the sphincter muscles; *third*, where the rupture extends into the rectum, involving the sphincter vaginae and the superficial sphincter ani muscles; *fourth*, where the rupture extends not only through the sphincter of the bowel, but also into the recto-vaginal septum. A fifth variety has been noticed, in which the head passes directly through the perineal centre, leaving the sphincter of the vagina and the sphincter of the bowel untorn. This, however, must be an exceedingly rare injury.

RESULTS OF LACERATION.—The evil effects of laceration of the perineum will depend on the degree of rupture. When only the posterior commissure is severed, a very common accident, little or no inconvenience follows. If, however, the rent extends beyond this, no matter how small the degree, evil almost invariably follows. When the rupture reaches the margin of the anus, the uterus loses an important support. The utero-sacral ligament yields, and the organ descends, giving rise to prolapse or procidentia. In addition to this, the posterior wall of the bladder and the anterior wall of the rectum are apt to protrude. The effects of these several displacements are a sense of dragging, weight, and weariness about the loins, incapacity for walking or standing, irritability of the bladder, and often indigestion, with disturbance of the nervous system. When the rupture extends through the sphincter muscle of the bowel, there follows a kind of disability infinitely more serious than those already named. All control over the intestinal contents is lost, feces and gas passing involuntarily; the person and clothing of the patient are constantly soiled and rendered offensive by the escape of the contents of the bowel. The mortification caused to a sensitive mind by an infirmity of this nature is exceedingly great, and is often instrumental in driving the unfortunate sufferer into seclusion. I know of no surgical achievement which brings greater satisfaction to an operator than the successful restoration of a lacerated perineum, rescuing a patient from such an infirmity, and restoring her to the society of her friends.

CHANGES FOLLOWING LACERATION.—Slight lacerations appear only to increase the antero-posterior extent of the vulva, but when the sphincter muscles are severed the deformity resulting is quite conspicuous. The posterior extremities of the greater labia are drawn asunder by the retraction of the transverse perineal muscles, and turned upward by the sphincter vaginae and the anterior fibres of the levator ani. When the recto-vaginal septum is torn, the mucous membrane of the bowel will project both forward into the

vagina and downward, as in prolapse of the bowel. On the completion of cicatrization the chasm is somewhat lessened, though the appearances are not materially changed.

TIME OF OPERATING.—With regard to the proper time there has been no small difference of opinion among writers, some advocating primary and others secondary operations. By primary operations are meant those done at the time of the accident, when the surfaces are raw; by secondary operations, those which are undertaken after cicatrization has been completed and the tissues have become sound. I shall not enter into any discussion on this point. Whenever an accident of this nature occurs to an obstetrician, and the rent does not include the sphincter of the bowel, the time to operate is immediately after the reception of the injury. The edges of the rent are then fresh, and, although exposed to the irritating lochial discharges, if neatly approximated they will probably adhere. When, however, the rupture extends into the rectum, the case should be left until cicatrization and consolidation of the fibres are completed, which will require not less than two months.

METHOD OF OPERATING.—The literature of rupture of the perineum exhibits a singular want of accord as to the best plan to be pursued in order to effect a cure. Celsus had no remedy but to tie the limbs of the patient together and enforce rest. Deleurye* affirms that extensive ruptures can be cured in this manner. Aitken† ignores sutures; D'Outrepoint, Busch, and Moser do the same; and to the same effect are the statements of Paletta,‡ Gardieu,§ Boyer, and Duparcque.|| And to these authorities may be added Waller, Blundell, and Davis. Ambrose Paré advises the use of sutures, and Mauriceau inculcates a similar practice, though neither, perhaps, ever carried his suggestion into effect. The first recorded case of this operation was by Guillemeau,¶ and among its earlier advocates may be mentioned Moreau, Smellie, De la Motte, Morlanne, Suncerotte, Mayo, Bond, Churchill, Alecock, Campbell, Osiander, Williams, Langenbeck, Roger, Dieffenbach, Dupuytren, Roux, Chelius, Burns, etc.

Among British surgeons, the most conspicuous name associated with the treatment of laceration of the perineum is that of Baker Brown. The chief features of this surgeon's operation were extensive denudation, the use of quilled alternated with interrupted sutures, and division of the sphincter ani on each side. Since the introduction of the silver thread by Sims, the operation by suture may be regarded as a very successful one. The first to use metallic sutures in the treatment of this injury was Dr. Mettauer,** of Virginia, in 1830. The substance employed was lead wire.

OPERATION.—In *primary* operations the parts are to be brought together by silver sutures, which should include the tissues to the full depth of the rupture. They should be allowed to remain seven or eight days before being removed. The number of the sutures will be determined by the extent of the rupture. They should not be more than three-eighths of an inch apart. The tissues are flaccid, without elasticity, and exert very little strain on the stitches. The parts are to be kept clean and free from the vaginal discharges by a stream of water colored with a solution of permanganate of potash and applied morning and evening by means of a syringe.

In *secondary* operations, the treatment will include a period of preparation, the operation, and the after-management.

PREPARATION.—When the attention of the surgeon is first invited to a case of rupture of the perineum, the patient will frequently be found suffering from diarrhoea, indigestion, and a train of distressing nervous symptoms,

* *Traité des Accouchements*, p. 134.

† *Principles of Midwifery*, 1788.

‡ *Exercitationes Pathologicae*, pars ii., Mediolani, 1826.

§ *Traité complet des Accouchements*, tome iii.

|| *Histoire complète des Ruptures et des Déchirures de l'Utérus, du Vagin et du Périnée*.

¶ *Guillemeau's Surgery*, chapter viii. p. 354.

** *American Journal of the Medical Sciences*, 1850, vol. xx. p. 329.

many of which have been aggravated by the reprehensible practice of administering regularly laudanum and other narcotics. To correct the intestinal disturbance, the diet should be carefully regulated, allowing meat, milk, rice, and stale bread, with very few vegetables.

The bed on which the patient is to lie should be a firm hair mattress, protected by a piece of rubber-cloth, over which is to be placed a folded sheet. The evening previous to the operation the bowels must be opened by a gentle laxative, followed by twenty drops of laudanum. For the satisfactory execution of the work, four assistants will be required,—one to take charge of the anæsthetic, one to support each limb, and one to attend to the sponges, the handing of instruments, etc. The position best adapted to the operation is on the back, across the bed, the hips projecting over its side, the limbs flexed on the body and separated.

The instruments required are a keen-edged scalpel (Fig. 1433), a pair of rat-toothed forceps (Fig. 1434), a pair of scissors slightly curved on the flat (Fig. 1435), a long needle with the eye near its extremity, and mounted on a handle (Fig. 1436), some iron and silver wire, a few shot, and a shot-compressor. (Fig. 1437.)

FIG. 1433.

FIG. 1434.

FIG. 1435.

FIG. 1436.

FIG. 1437.



The patient being placed in the lithotomy position, as described above, the operator, with a keen-edged scalpel, and sitting in front of the perineum, commences the denudation of the sides of the laceration. This must extend inward sufficiently far to include a very little of the mucous membrane of the vagina, outward towards the buttock, and upward, so as to include a por-

of the base of each labium. The entire breadth of the freshened surface must not be less than one inch. In depth it is only necessary to remove the thinnest possible film of tissue. To go deeper than this is useless, and may cause a troublesome loss of blood. The vivified surfaces should be alike on the two sides, and must join at their anal extremity. The work of denudation may be facilitated by an assistant keeping the parts on the stretch.

The bleeding is rarely sufficiently copious to demand the use of a ligature: any vessel which continues to bleed should be treated by torsion. Obstinate oozing which does not subside on the application of a stream of cold water from a syringe can be promptly subdued by applying to the raw surface a napkin wet in very hot water.

Introduction of sutures.—The approximation of the edges of the wound is now to be effected by metallic sutures, which are to be introduced, the first at the posterior or anal extremity of the laceration, and the others in their regular order forward.

The first suture is the most important one; indeed, on its proper disposition depends the success of the operation. As it should include a considerable extent of tissue and is placed on some strain, I prefer for the purpose iron thread coated with silver. When the sphincters have been torn, the needle is entered five-eighths of an inch from the margin of the wound on one side, at the anterior part of the ischio-rectal fossa and below the level of the anterior wall of the anus, and is carried forward and upward, guided by a finger in the rectum, until the point is made to emerge at the middle of the recto-vaginal septum, about one-sixteenth of an inch above the junction of the raw surface and the mucous membrane. As soon as the eye of the instrument becomes visible, it is to be threaded with the iron suture and then withdrawn, thus leaving the wire in one side of the rupture. This done, the needle is to be detached from the thread and passed unarmed in the same manner through the corresponding tissues on the other side, its point coming out near to or at the opening made by the instrument in the septum at its first passage. The vaginal end of the wire is now passed through the eye of the needle; as the latter is withdrawn the suture makes the entire circuit of the wound. The second thread is to be inserted about three-eighths of an inch anterior to the first, except where it appears on the septum, which should not be over a quarter of an inch above the preceding wire. The remaining sutures, consisting of stout silver wire, seldom more than two or three being required, are next to be passed across the wound, entering and coming out three-quarters of an inch from the margins of the freshened surfaces and barely including the mucous membrane of the vulva, and then crossed from side to side. (Fig. 1438.)

The ends of each suture on being introduced are to be passed through a perforated shot, bent, and twisted round, so as not to become separated.

Closure.—All blood-clots being sponged away, the surgeon untwists the ends of the posterior wire in order to liberate the shot, and the sides of the opening are brought together much in the same way as the cord of a purse or satchel puckers up the orifice which it surrounds. The adjustment will be facilitated by an assistant pressing at the same time the sides of the nates towards each other. As soon as the operator is assured that the denuded surfaces are in contact, the shot is to be run down and clamped on the wire by the compressing forceps. Each suture in turn is to be tightened and secured in the same manner; after which the wires should be cut off on a level with the surface of the shot. (Fig. 1439.) At one time, following in the track of other surgeons, I was in the habit of inserting between these primary deep sutures superficial metallic ones with an ordinary needle; but for several years, convinced of their uselessness, I have abandoned the practice.

The urine being drawn and the knees tied together, the woman is now put to bed, the position on the back being preferable for the first few hours, after which she may be changed to either side as may be most comfortable.

AFTER-TREATMENT.—For the first two or three days the bowels should be

kept quiet, and for this object, if required, half a grain of opium in pill may be given once or twice for one or two days. After this period a teaspoonful of compound liquorice powder, taken at bedtime every second night, will secure a soft passage the following morning; after which the perineum must be washed with a stream of sublimate water projected from an ordinary syringe.

FIG. 1438.



Surfaces denuded and sutures in position.

FIG. 1439.



The laceration closed.

If the bowels are kept confined until after the sutures are taken away, which was a common practice and one which I formerly approved of, the rectum frequently becomes impacted with hard fecal accumulations, the extraction of which seriously endangers the soft bond of union between the edges of the wound. The urine should be drawn morning and evening, or oftener if the state of the bladder demands it. Catheterization after an operation for ruptured perineum can be most conveniently accomplished with the patient on the side with the limbs well drawn up. When the physician is at a distance, rendering it inconvenient to make more than a single daily visit, and the nurse is incompetent to use the instrument, the self-retaining catheter of Sims can be worn. After four days the patient may be allowed to pass the urine voluntarily, a bed-pan being placed under the hips to receive the secretion. Before removing the pan it is well to take the precaution to introduce the nozzle of a gravity douche into the vagina and drench the parts with a solution of permanganate of potash or with tepid water, so that the wound may be freed from the irritation of the urine. After the third day, a piece of soft linen spread with benzoated oxide of zinc ointment, or with vaseline, laid against the surface of the wound, will add to the comfort of the patient.

Patients sometimes suffer greatly with flatulence after the operation: when this symptom does not yield to the use of a carminative, a gum catheter passed a little distance into the rectum will give exit to the accumulation.

Nervous restlessness is best controlled by one of the bromides. The diet should consist principally of milk, beef-tea, eggs, coffee, chocolate, and bread.

Removal of stitches.—On the seventh day—never later than the eighth—the sutures must be removed, in the reverse order of their insertion. In doing this, the hips of the patient must rest on the edge of the bed, and, that the threads may be taken away with as little pain as possible, each wire should be cut on one side near the shot-clamp, then the hook at its end straightened, to prevent scratching while drawing it out. During the traction of the wire or the silkworm-gut it is a good plan to make counter-pressure against the loop with the blades of the scissors. After the extraction of the sutures, the knees are still to remain bound together for four or five days, and at night for as many more. On the tenth day the patient may be allowed to sit up, and afterwards she may gradually resume her usual duties.

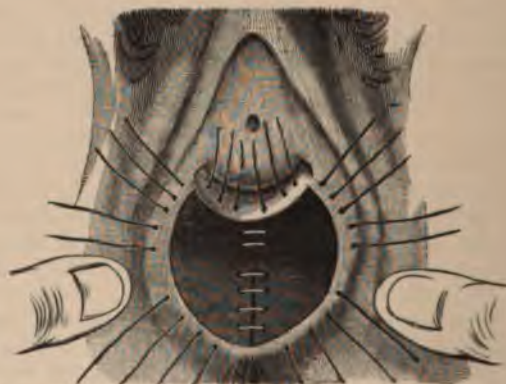
The quilled sutures, which were employed in the earlier operations of Baker Brown, and thirty years earlier by Roux, Dansul, and others, and the lateral incisions, are, since the introduction of the aseptic thread into surgery, rarely resorted to.

When failure follows an operation in a case of laceration extending into the rectum, it is usually to be attributed to the imperfect manner in which the posterior suture has been applied. The parts have not been properly pursed, and the consequence is an opening between the rectum and the vagina, which ends in a permanent fistula, rendering a second operation necessary, and which, though it may be small, will sometimes resist all attempts to close it, and will require that the parts be laid open to the original extent and their closure commenced anew.

When the sphincters have been torn, and the rent involves also the recto-vaginal septum, a different procedure will be required. After cleansing the parts, a tenaculum is inserted into the middle of the septum, a short distance above the upper end of the rent. This is committed to an assistant, who places the parts on a moderate stretch. The operator then freshens with the knife, or with scissors curved on the flat, the mucous surface of the septum from the junction of the cutaneo-mucous line on one side to a corresponding line on the other side, not extending upward higher than the lower extremities of the nymphæ. At each lower end of the rent, where the parts are retracted by the torn end of the sphincter, a strip of the mucous membrane of the rectum should be removed and a piece of the tissue cut out at each extremity in order to expose the ends of the sphincter.

Introduction of sutures.—The next step is the introduction of the sutures. The silkworm-gut answers the purpose best. The needles need not differ from the common sewing-needle. Some of them should be longer than others. The parts being still kept tense by the tenaculum, the first stitch is inserted at the upper horn of the crescent-shaped wound on one side, and brought out on the same side through the mucous membrane a little beyond its freshened surface. A second and a third are introduced in the same manner, when a similar number are inserted through the other side. The next sutures are passed in the course of an ellipse across the wound, each entering a little distance from its margin on one side, passing deeply beneath the vaginal mucous membrane, coming out near the middle of the septum, again re-entering beneath the mucous membrane, and coming out on the opposite side a short distance beyond the vivified surface. The last or crown stitch in-

FIG. 1440.



Recto-vaginal septum denuded, the upper part being crescentic in form, and the stitches introduced.

cludes the extremity of the torn sphincter. (Fig. 1440.) The approximation is then made by drawing together the ends of the sutures and clamping each with shot.

Malformations of the Vagina.

Malformations of the vagina are both congenital and acquired. Among those which may be noticed as congenital is the *double vagina*. I have seen

a number of examples of this condition. Generally, the partition which forms the septum of the canals is placed against the middle of the os uteri, so that the latter opening communicates with both vaginae, or there may be a double uterus. In one instance I observed that the neck of the uterus was wholly in one canal, the other having no connection whatever with the os uteri. The lady, who was conscious of something unusual in the construction of the parts, and who consulted me in consequence of contemplated marriage, appeared much delighted at the prospect of one channel being used without the risk of becoming pregnant. The vagina being developed from Müller's canals, all its abnormalities are the result of the imperfect development of these two channels. The vagina occasionally opens into the rectum or the bladder.

Incomplete Vagina.—The canal of the vagina is sometimes very short, constituting only a shallow depression, and terminating in a *cul-de-sac*; or it may possess the normal length, and yet end in a blind pouch, without having any communication with the os uteri.

Absence of the Vagina is occasionally met with, where no trace of the canal can be seen on the surface of the perineum; and yet in a case of this kind which came under my notice the mons veneris was surmounted with an unusual growth of hair, and the woman well developed in all other respects, and possessed of the usual sexual feelings. A rudimentary uterus, it was thought, could be felt by a rectal examination. Entire absence of the vagina can be determined only by introducing a catheter into the bladder and a finger into the rectum, approximating the two. If the intermediate tissue appears to consist only of a thin membranous layer, the absence of the canal may be inferred.

Congenital imperfections of the sexual apparatus are sometimes found associated with other abnormalities of the body. A woman was brought to me from Western Pennsylvania for examination. She possessed a strong, masculine build, was six feet in height, and had a deep, coarse voice. The vagina was a mere depression or shallow cleft in the perineum. The uterus appeared to be absent; very little hair existed over the pubes; the breasts were rudimentary, and several large hard tumors, apparently malignant in character, occupied the cavity of the abdomen. The woman, so far as I could learn, had never experienced any sexual desire.

External Closure.—The entrance to the vagina is sometimes barred by the fusion of the labia majora or labia minora, or by a firm hymen.

Acquired Stenosis and Atresia follow from causes which are either mechanical, chemical, or pathological. Among the mechanical causes, none play so important a rôle as prolonged labor. The long detention of the head in the pelvic cavity destroys by pressure the vitality of the mucous membrane of the vagina, causing it to slough. The resulting cicatricial tissue produces narrowing of the canal, or its surfaces may unite and thus obliterate the cavity altogether. Wounds caused by falling on a pointed body, which lacerates the walls of the vagina, are likely to be followed by serious stenosis of the canal.

Caustic acids applied to the interior of the vagina are often sufficient to produce extensive ulceration, sloughing, and subsequent narrowing or adhesion of its surfaces.

Pathological atresia includes all those cases of sloughing which are due to syphilis, smallpox, and certain low fevers, as typhus. Stenosis and atresia produce evil effects by rendering the canal unfit for coition, parturition, or the escape of the menses.

TREATMENT.—Generally it may be said that cases of absence of the vagina admit of no treatment, as in almost all instances there is also an absence of the uterus. Should there be, however, a very short canal, terminating in

a *cul-de-sac*, and after a careful examination a uterus can be discovered, an operation will be proper.

In making the exploration in search of the uterus in these cases, in order that the examination be satisfactory it is necessary that the woman be etherized, and placed on her back, with the shoulders and body well flexed so as to relax the abdominal parietes. With one or two fingers of one hand in the rectum, and those of the other pressing firmly over the hypogastric region, the surgeon may be able to feel the uterus.

Communications between the vagina and the bladder, or between the former canal and the rectum, which may exist as a result of either congenital or acquired atresia, are to be closed when practicable, as in vesico-vaginal fistula. In one case which I presented to the medical class at the Pennsylvania Hospital, in which a recto-vaginal opening existed with anterior atresia, a cure was effected by laying open the parts in the median line and completing the vagina anteriorly.

Stricture.—When the canal is contracted at some part of its course from the effects of a circumscribed slough, the coarctation or stenosis is best corrected by simply dividing the cicatricial tissue with a bistoury, and using a certain amount of forcible dilatation by means of graduated cylindrical specula or bougies.

This operation I have frequently repeated in order to obtain room to close a vesico-vaginal fistula situated behind the stricture.

A stricture may also exist from inflammatory deposits in the submucous connective tissue of the canal, and interfere both with coition and with parturition. The contraction can be overcome by dilatation with graduated bougies, and, if it offers a serious obstacle to the passage of the foetus, may be divided by either a subcutaneous or an open incision made during the presence of a pain.

Atresia, when acquired, may be limited to the deep portion of the vagina, or it may include almost the entire length of the canal. These are cases which demand the utmost care in an operation to avoid opening the bladder or the rectum.

The patient, having been etherized, is placed on her back across the bed, with the hips projecting over its edge, and the limbs flexed on the pelvis and supported on either side. A sound or staff being now placed in the bladder and given to an assistant, the surgeon, with a finger in the rectum, carries his dissection cautiously inward, either with a bistoury or with a pair of curved scissors, constantly referring to his guides, the sound and the finger, to ascertain that he is not wandering from the proper line. Frequently after deepening the incision a little distance the finger at certain points may be substituted for the scissors or knife in breaking up adhesions, lacerating bands, and enlarging the opening, until the neck of the uterus is reached. Amussat, in a case of retention of two years' duration, succeeded after dividing the skin with a bistoury in working his way to the uterus by using only the finger-nails for tearing the tissues. The laceration was effected by three operations at intervals of three days. As a rule, the difficulties thicken as the neck of the uterus is approached; and, that no hap-hazard cuts be made, it has been advised to introduce the fingers well up into the rectum so as to grasp the body of the uterus and at the same time force its neck down towards the vagina, when it may be recognized by the operator.

After the operation has been completed, the introduction of plugs or a gum bougie, coated with oil or cold cream, becomes necessary to counteract the subsequent tendency to closure.

The fenestrated cylindrical glass or rubber speculum has the advantage over other means used for dilatation, in that discharges can escape through the opening in the instrument, thereby contributing to the safety of the patient.

Operations for congenital atresia should be performed about the period of puberty, or before the establishment of the menstrual function.

Retained Menses.

One of the great evils resulting from imperforate vagina, whether congenital or acquired, is the retention of the menstrual secretion. The distention of the uterus from an accumulation of this nature, the product of repeated menstruation, is sometimes so great as to raise the organ from the pelvis into the abdomen, giving the patient the appearance of a woman five or six months advanced in pregnancy. When the obstruction is due to an unyielding and imperforate hymen, to fusion of the labia, or to a partial occlusion of the vagina, a distinct impulse can be detected, and even a protrusion of the septum seen, during coughing or straining efforts.

TREATMENT.—The treatment will consist in opening a way for the escape of the retained secretion. When a dense hymen constitutes the obstructing medium, a crucial incision should be made. If the retention is caused by union of the labia, a vertical incision will be required; if by occlusion of the vaginal canal, congenital or otherwise, the same course is to be pursued as has been described for the relief of atresia.

Operations of this kind are not unattended with danger. Many cases die from subsequent peritonitis, not because of the incisions which are made, or from the admission of air to the menstrual fluid and its decomposition giving rise to endometritis or pyæmia, but from the escape of a portion of the menstrual blood through the Fallopian tube into the abdominal cavity.

It may appear singular that a Fallopian tube which has resisted any escape of fluid from its cavity during the period of its great distention should permit such an accident after that distention has been removed by an operation; yet there is little doubt that this is the case. The explanation which has been given of this apparent paradox is probably the true one, namely, that the powerful contraction of the uterus which follows the evacuation of its contents drives a certain quantity of the menstrual fluid back into the Fallopian tubes, which, in consequence of their walls being overstretched and weakened, do not possess the power to resist the additional uterine force, and thus allow a portion of their contents to pass through their free extremities, or, as has happened, their walls may give way by ulceration the result of inflammation. It is not improbable, from some experiments made by Matthews Duncan, that portions of the menstrual blood may be forced by the contractile power of the uterus through its own tissues and those of the Fallopian tubes into the peritoneum without causing any visible lesion, and thus give rise to peritonitis.

To avoid the great risk of extravasation, some advise making a small opening or puncture, thus allowing the fluid to drain away *slowly*. Twice I have relieved menstrual accumulations by free incisions, and without any ill effects. In one of the cases, that of a patient of Dr. Elwood Wilson, of this city, the obstruction originated from a protracted labor, the physician allowing the head to remain so long in the vagina without rendering instrumental aid that sloughing occurred in nearly the entire length of the canal, and this was followed by complete atresia, rendering it necessary to divide a long extent of cicatricial tissue. Quite a gallon of a thick, tarry fluid was discharged. The other case, which was under the care of Dr. Jacob Roberts, of Philadelphia, was produced in the same manner, but involved less structural damage to the vagina, and was much more recent in its duration. After the collection has been evacuated, vaginal injections of warm carbolic water, or of permanganate of potash, should be used. The aspirator is a convenient instrument for removing accumulations of this nature in a manner which obviates all the objections urged against free incision, preventing the intrusion of air, and effecting the evacuation in a very gradual manner. The aspirating trocar, when the obstruction is seated at or near the orifice of the

vagina, can be pushed immediately into the canal; or, when there is complete atresia, it may enter the uterus either through the abdominal walls or through the rectum. The operation should be repeated every four or five days, and only a few ounces removed at a time. In the very slight and gradual contraction of the uterus which follows may consist the patient's safety. In all cases of retained menses, early operations are of vital importance, as likely to avoid those dangers which attend old and large accumulations.

Fissure of the Vagina is seated at the ostium, and almost invariably at the posterior part.

A linear ulcer from one-quarter to three-eighths of an inch in length constitutes the disease. It is caused usually by laceration of the fourchette in delivery. It is often productive of much suffering in urination, defecation, and coition, and may develop a troublesome vaginismus, and finally a train of very troublesome nervous symptoms. It will disappear under the local use of iodoform, rarely requiring incision.

Ulceration.—Ulcers of the vagina are common, specific, and malignant, and must be treated on principles applicable to similar affections in other regions of the body.

Prolapse of the Vagina is rarely seen in young females, but is exceedingly common among married women, and not unfrequently is observed in the unmarried after middle life.

It is generally complicated with, indeed is often dependent on, descent of the womb, hernia of the bladder or the rectum, or laceration of the perineum. The prolapse may involve the whole circumference of the tube, or it may be limited to the anterior wall, especially when accompanied by cystocele, or the posterior wall alone may protrude, conjoined with a rectocele.

The prolapse appears as a soft, red or bluish tumor, globular in form, with circular wrinkles, projecting from the vulva, and even extending down between the thighs. It imposes no small degree of disability. Standing, walking, and lifting are followed by uneasiness and weakness. Dragging lumbar pains are complained of, and very commonly there is much irritability of the bladder.

There is some resemblance between prolapse of the vagina and prolapse of the uterus, cystocele, rectocele, and uterine polypus. (Fig. 1441.)

FIG. 1441.



Utero-vaginal prolapse, with cystocele and rectocele.

In *procidentia uteri* the tumor is devoid of wrinkles, and firm, and the orifice of the os can be seen,—appearances having little resemblance to those characterizing a prolapsed vagina, which is soft, globular, and rugose.

In *cystocele* the tumor enlarges during the accumulation of urine, and subsides on the passage or withdrawal of the contents of the bladder.

Rectocele can be recognized by inserting a finger into the rectum, when it can be carried

forward into the pouched intestine. A *polypus* is pedunculated, hard, and smooth on its surface, and not easily restored into the vagina.

TREATMENT.—The treatment for the relief of prolapse is medical, mechanical, and surgical.

The medicinal agents employed are large injections of cold water, in which should be dissolved some astringent,—alum, tannic acid, common salt, or a

little Monsel's solution of iron. If the woman is weak and in feeble health, the general strength must be improved by enjoining sufficient rest, and the use of iron, quinine, and strychnia, and, when circumstances will permit, by sea-bathing and carriage-riding.

The mechanical treatment consists in reducing the prolapsed vagina, and retaining it in place by a lever pessary. The ring and ball pessaries will also furnish the necessary support, but they have the disadvantage of keeping the canal dilated. Sometimes no contrivance will prevent the descent of the vagina except a stem pessary. (See *Procidencia Uteri* for these different pessaries.)

When the prolapse depends on the existence of a ruptured perineum, no mechanical appliance can be used with advantage until the laceration is closed.

The surgical management of prolapse of the vagina must be determined by the degree of displacement. It may be sufficient to freshen a portion of the opposing surfaces of the labia majora and unite them by sutures,—an operation to which the name of episiorrhaphy has been given. I have resorted to this plan several times with marked relief. When the prolapse is utero-vaginal, or cysto-vaginal, or recto-vaginal, it may be necessary to narrow the cavity of the vagina (see *Elytrorrhaphy*) in order to secure the needful support.

Tumors of the Vagina are quite uncommon. Those which have been observed are the cystic, the fibrous, and the papillomatous.

Cystic tumors originate in one of the mucous follicles of the canal, the walls of which become distended and thickened, and contain a ropy, viscid secretion. These growths are sometimes multiple or in clusters; they rarely attain any great size, and have an elastic feel, and a smooth, almost polished surface. Incision of the sac effects a cure.

Fibrous tumors are formed in the submucous connective tissue of the canal, attain considerable size, and differ from similar growths elsewhere in being less dense and compact in their structure. They often grow to the size of a marble and then remain quiescent. In this condition, unless attended with pain, it is better not to interfere, but when their growth is progressive they should be laid open and enucleated.

Papillomata are sometimes met with in the vagina primarily, but oftener as secondary to the like disease of the neck of the womb. These growths, which consist of hypertrophied papillæ, simple or compound, and covered with epithelium, present a villous appearance. They are richly supplied with blood-vessels, and bleed profusely when rudely handled. Excision and cauterization with the acid nitrate of mercury suffice for their eradication.

Epithelioma is rarely seen in the vagina earlier than the fortieth year, and in a large majority of instances it occurs in women who have borne children. The disease appears at first as a wart-like excrescence, and as it progresses forms exuberant cauliflower-like granulations covered with pavement epithelium. These growths ulcerate, break down, and furnish a foul sanious discharge, which irritates the surrounding parts, and tends to implicate the sacral, iliac, and lumbar glands which receive the lymphatics of the vagina. Epithelioma in its progress is attended with much suffering, which, with the contamination of the blood, wears the patient out in the course of one or two years.

When discovered very early and the disease is quite limited, it should be excised and the surface cauterized with the thermo-cautery.

Rodent ulcers have been observed in the vagina, and might be confounded with epithelioma. The absence, however, of cauliflower excrescences, the freedom of the glands from contamination, and the tardy progress of the disease would suffice to distinguish it from epithelioma. The remedy excision.

Gonorrhœa.

Gonorrhœa in the female differs from that in the male. In the former the urethra generally escapes the infective inflammation, the parts affected being the vulva and the vagina. The disease may also extend into the uterus, and thence even to the Fallopian tubes and the ovaries.

The period which elapses between impure connection and the development of a gonorrhœal vulvitis and vaginitis does not differ materially from that in the male.

SYMPTOMS.—The disease is ushered in by heat, itching, smarting of the vulva and vagina, and a feeling of weight in the perineum. The parts become swollen and sensitive, and are soon covered with a profuse muco-purulent discharge, which as it flows from the inflamed surfaces often causes excoriation of the surrounding parts. Though there is frequently considerable smarting during the passage of the urine, it is not occasioned by its contact with an inflamed urethra, but by the water dribbling over the external genitalia, which are congested or inflamed. Sometimes the discharge instead of having the consistency of a purulent fluid is tough and stringy and adheres tenaciously to the diseased mucous membrane. As in males, so in females, when the attack is one of more than common severity, there will often be experienced a sense of great fullness deeply seated in the perineum, and accompanied with pains extending into the groins, down the thighs, or into the small of the back. The inguinal lymphatic glands are also frequently enlarged. When the inflammation travels upward and implicates the womb, there will be found the usual purulent discharge filling up and escaping from the mouth of the organ, modified somewhat by the mucus derived from the glands of the cervix uteri, which imparts to the fluid a tangled, ropy consistency, rendering it sometimes difficult to dislodge it from the os.

DIAGNOSIS.—It is often a delicate as well as a difficult matter to differentiate the discharge of gonorrhœa from that arising from other causes, especially leucorrhœa. Indeed, in many instances it would be unsafe to give other than a very guarded diagnosis. The character of many women, and the peace of many households, have been most unjustly damaged by medical opinions couched in language which conveys the idea of suspicion. Generally, however, there is in leucorrhœa a less fiery redness of the mucous membrane of the vagina than in gonorrhœa; there is also an absence of smarting during and after micturition; the lymphatic glands are not involved; the inflammation, moreover, does not extend to the external genitalia, as the nymphæ, labia, and clitoris; nor do the abrasions or excoriations and the pain which so commonly belong to gonorrhœa exist in leucorrhœa. These characteristics, in conjunction with the known character of the party whose purity may be suspected, will contribute somewhat to the solution of a doubtful question. Many women suffer innocently from chronic gonorrhœa, contracted from a husband who labored under a slight gleet discharge at the time of their marriage. The latent gonorrhœa spoken of by Noeggerath as so common among married women, he attributes to the husbands having had at one time a specific urethritis. The statements of this author are entirely too sweeping. The mere fact of a man having had a gonorrhœa in the past does not render it probable that his wife will suffer from the disease, unless he still labors under a urethral discharge at the time of marriage.

Discharges from the vagina are frequently observed even in young children, and I have known mothers to suffer the greatest mental distress under the impression that their children had been the subjects of impure approaches.

TREATMENT.—Except in cases where the inflammation has entered the urethra, the treatment of gonorrhœa in the female is a purely local one. At the beginning of an attack the patient should be confined to bed, a gentle

saline cathartic administered, and the diet restricted to the simplest and least stimulating articles of food (as bread, milk, tea, and light broths). The vagina should be washed out with a douche, twice a day during the first two or three days, using a hot sublimate solution (one to four thousand). The next step consists in medicating the inflamed surfaces with injections of sulphate of zinc or of copper. The surfaces should be kept apart, so as not to come in contact and consequently maintain the inflammation by repeating the inoculation through the muco-purulent discharges which they furnish. For the purpose of medication and to preserve the separation of the vaginal walls, I have employed for a long time lint saturated with a solution of sulphate of zinc, at first of the strength of four grains and finally of fifteen grains to the ounce of water. The lint should be cut in a single long strip, and introduced into the vagina through a speculum, packing first the deep part of the canal, and afterwards the anterior part as the instrument is withdrawn. This packing may be allowed to remain eight hours, and can be removed by the patient seizing the end which lies in the vulva and drawing the strip gradually away. A few applications of the lint, made once in twenty-four hours, will soon subdue the inflammation and suppuration. Dr. John Black, of New Castle, Delaware, while a resident physician at the Philadelphia Hospital, employed with considerable success vaginal suppositories, after the plan of Sir James Simpson, composed of alum, persulphate of iron, tannin, etc. When the inflammation involves the urethra, the latter should be wiped with a little mop of absorbent cotton, well soaked in a solution of sulphate of zinc (six grains of the salt to two ounces of water), and carried along the canal, held in the grasp of a pair of forceps. Internally balsam of copaiba acts with the same efficiency as in the male, and ranks among the most valuable of our remedies.

COMPLICATIONS.—Many complications are found to follow specific vaginitis. Among them may be named bubo, abscess, vulvo-vaginal adenitis, mucous patches, endometritis, inflammation of the Fallopian tubes and ovaries, peritonitis, pelvic cellulitis, and cystitis.

Inflammation of the inguinal glands is rarely witnessed unless the urethra has been implicated in the disease, and must be managed on the same general principles as gonorrhœal adenitis in the male, namely, by leeching, blistering, anodyne lotions, painting the glands with compound solution of iodine, or rubbing into them an ointment of iodoform. If resolution cannot be obtained, suppuration should be encouraged by flaxseed-meal poultices, and the pus evacuated by a free incision as soon as fluctuation can be discerned.

Abscess.—When the inflammation extends into the connective tissue underlying the mucous membrane, vulvar abscess is liable to follow, and will declare itself by pain, redness, throbbing, swelling, and pointing, the summit of the latter presenting a purple discoloration. Poultices until the abscess matures, and evacuation with a bistoury, constitute the treatment.

Vulvo-vaginal adenitis, first noticed by Salmons, though regarded as common by this writer, is in my experience quite uncommon, and when present rarely passes on to suppuration. The enlargement of the vulvo-vaginal glands is accompanied by the presence of a considerable induration, discoverable by the touch, on either side of the vagina, and also by undue prominence of the nymphæ.

The treatment will be the same as that proper in cases of inflammation of these glands from causes other than specific.

Mucous patches are to be removed by the constant use of astringent and absorbent powders, as tannic acid or persulphate of iron, or by touching these vegetations with a little nitric acid or acid nitrate of mercury, at the same time keeping the mucous surfaces asunder by the interposition of soft lint or absorbent cotton.

Inflammation of the Fallopian tubes and ovaries results from an extension of the inflammation by continuity of structure, and is to be treated by leeches, rest, gentle cathartics, warm vaginal douches, and opium suppositories to

allay pain when present. When large collections of pus form (pyosalpinx), the removal of the tube becomes necessary. The same course will be proper in cases of hydrosalpinx and hæmatosalpinx.

Endometritis.—Inflammation in the cervix uteri or abrasion of its surface yields to the use of the solid stick of nitrate of silver. When the disease involves the body of the uterus, and does not subside under rest, gentle aperients, and hot-water douches, the cavity of this organ may be treated by means of a weak solution of nitrate of silver (two grains to the ounce), or of a mixture composed of one part of iodine and ten parts of glycerin, applied with a mop. When followed by bleeding granulations, it may become necessary to curette the cavity of the organ, in order to arrest hemorrhage.

Peritonitis sometimes, though rarely, occurs, and will require the usual treatment,—leeching over the abdomen, hot poultices, and opium, with saline cathartics.

Pelvic cellulitis may be caused by an extension of inflammation from the vulvo-vaginal glands, and is a very dangerous complication. Much will depend on an early recognition of the inflammation, and its resolution by antiphlogistic remedies; or, in case suppuration occurs, the immediate evacuation of the pus by puncture when this is feasible, followed by the introduction of a rubber drainage-tube.

Cystitis in the female as a sequel of gonorrhœa is a more manageable disease than in the male. The internal use of copaiba, and of diluents containing a small amount of carbonate of soda, constitutes the best treatment.

Granular vaginitis.—A form of vaginitis first pointed out by Ricord has been described under different names by Deville, Guermant, and others as *glandular*, *papular*, or *follicular vaginitis*. There is a difference among writers as to its true pathology, some regarding it as an inflammatory hypertrophy of the muciparous glands of the vagina, while others believe it to be a similar enlargement of the normal papillæ of the mucous membrane of the canal. The latter view coincides with my own, though I have had an opportunity of observing only a limited number of such cases.

The disease appears in the form of small, round granulations, the size of a mustard-seed, scattered over the vaginal mucous membrane, and occupying also the cervix uteri. It is generally met with during pregnancy, and is often accompanied with pruritus of the vulva, giving rise to great local distress and nervous disturbance. The remedies are those employed for the treatment of specific vaginitis.

The disease subsides spontaneously after parturition.

Vesico-Vaginal Fistula.

There is one accident liable to occur to the female during the exercise of the highest function of her sex, which until a comparatively recent period doomed her to a life of seclusion and despondency, rendered the less endurable by her being compelled to live, however isolated, in an atmosphere loaded with the volatile products of the urinary secretion. Such was the fate of a woman unfortunate enough to suffer from vesico-vaginal fistula, until American surgery achieved the conquest of the horrible infirmity.

Before the discovery of the forceps, vesico-vaginal fistula must have been very common, though very little allusion is made to the subject in the medical and surgical treatises of the time. Hippocrates alludes to cases in which after protracted labor the urine escaped from the vagina, but has no remedy to suggest other than attention to cleanliness. Mauriceau, who wrote in 1714, in speaking of these fistulæ, intimates that unless they heal spontaneously in the course of two or three months they are incurable. Hoffmann describes the manner in which these lesions of the bladder occur, but mentions no operation for their cure. The works of Astruc, who in 1776 held the important position of physician to the King of France, do not contain a single sentence on the subject. Smellie, whose work was published the

same year, speaks of an operation which had been performed for the cure of this fistula, but in language which clearly indicates that no success had been obtained. Burns, in his treatise on midwifery, has only the palliative remedy of the catheter to suggest as a means of relief. Conquest, in his book published the same year as the American edition of Burns by James, 1820, strongly urges the propriety of attempting a cure by operation, though no plan is described, nor does he lead us to believe that he had ever seen a single cure accomplished.

James, professor of obstetrics in the University of Pennsylvania, in his "System of Midwifery," published in 1813, speaking of vesico-vaginal fistula, bases the hope of a cure on the use of an elastic catheter, caustics, and vivifying the edges of the opening by the knife. He mentions no cures. Ashwell, a prominent writer in London, as late as 1828, makes no allusion whatever to this fistula. Gooch, in 1831, mentions a case which was cured by using as an obturator a gum bottle with a sponge attached, which was adjusted in the vagina in such a manner as to keep the sponge applied to the fistulous opening. Other instances of cures were reported by Lallemand, Vidal, and others, but Velpeau denies their verity. His opinion was doubtless shared by others; for the same year in which these recoveries were recorded, 1834, Blundell in his work summarily disposes of the accident in the following language: "A slough of the vagina may lay open the bladder;" while Ramsbotham, writing seven years later, 1841, does not speak of the fistula at all. Davis, while he briefly describes the manner in which the bladder is opened, concludes by saying that "it is a universal fact that the opening never does heal." Dewees makes no mention of the fistula, and Churchill introduces the subject only to say that all such accidents are hopeless. As late as 1866, Simpson, in speaking of sloughing of the vesico-vaginal septum, consigns the resulting perforation to the domain of incurable fistula.

If we turn from obstetrical to surgical writers, the result is the same. Ambrose Paré, while he discusses the different kinds of fistulae, does not name the vesico-vaginal variety, and Heister refers to it only to pronounce it incurable. Liston condemns all operations for the cure of this affection as useless, or, rather, worse than useless; for he says virtually that all such attempts only serve to convert a small opening into a larger one. Earle and Laurence speak of a successful operation as being impracticable; and to the same effect is the testimony of Chelius, Miller, and Velpeau. Pirrie ignores the subject entirely in his Surgery, as also do Dorsey and Gibson. Dupuytren and Desault speak only of palliative measures. Earle, after thirty attempts, succeeded in effecting a single cure. In 1839 and 1840, Dr. Hayward, of Boston, Massachusetts, succeeded in making three cures in twenty operations. In 1847, Professor Pancoast reported two cases of vesico-vaginal fistula which he had succeeded in closing by a tongue and grooved incision, brought together with silk threads. In the same year, Dr. Mettauer, of Virginia, published a cure in which the parts had been closed by leaden threads.

In 1852, Dr. J. Marion Sims, at that time residing in Montgomery, Alabama, placed before the profession the results of his labors in the treatment of vesico-vaginal fistula, by which the operation was removed from the region of uncertainty, and for which the world owes him a debt of eternal gratitude.

The peculiarities which characterized the method of Sims were: *first*, the enlargement and exposure of the cavity of the vagina, rendering the fistulous opening accessible, by the use of the duck-billed speculum; *second*, the use of a silver suture which would hold the parts securely together, and for a sufficient length of time to procure their union, without disturbing the healing by undue irritation or ulceration; *third*, the employment of a self-retaining catheter, thus keeping the bladder drained, and the wound protected from contact with the urine. It is true that Chelius and Walter had each employed a blunt hook for expanding the vagina; and it is true that

all the methods of treatment outlined in the above indications had been employed; but they had never been employed in a systematic manner. For example, the position on the hands and knees, or on the abdomen, was the one adopted by Wutzer, Chelius, and Metzler. In 1829, Levert, of Alabama, had used silver wire; Gosset, of London, in 1834, had employed gilded wire, and Deyber and Mettauer, of Virginia, leaden wire. The necessity for the catheter in the treatment of this fistula was known to Volter, of Würtemberg, as early as 1770, also to Gosset, Metzler, and Mettauer. Yet the honor and merit of improving, modifying, and combining into a consistent and practical system the crude and disjointed materials of his predecessors belong only to Sims.

CAUSES.—The causes of vesico-vaginal fistula are mechanical, pathological, and traumatic.

Mechanical.—Under this head may be enumerated badly-fitting pessaries, or pessaries which, either from corrosion or from the deposition of the salts of the urine, have by their rough and irregular surfaces provoked ulceration of the vesico-vaginal septum. Instances of this kind are noticed by Beirards, Lisfranc, Dupuytren, and Desormeaux.

In the same manner foreign bodies, as stone in the bladder, in consequence of their magnitude and irregular surface, may provoke ulceration and find their way into the vagina, leaving a fistulous opening. Twice have I known this to occur.

Pathological.—Carcinoma of the neck of the uterus not unfrequently extends to the vagina, bladder, or rectum, destroying their partition-walls, and converting these organs into a common cavity.

Phagedænic chancre I have twice seen produce the same result.

Traumatic.—Wounds of the vesico-vaginal septum terminating in fistula follow both the legitimate and the criminal use of instruments. The maladroit use of the vectis in attempts to rectify a vicious position of the foetal head, or of the perforator in performing craniotomy, may cause this accident, as these instruments are liable to slip and open the bladder. Even the forceps have been charged with playing an important part in producing lesions of the vesico-vaginal septum, though on very insufficient evidence. For my part, I know of no means so well calculated to prevent the accident as the timely employment of this instrument in skillful hands. The bladder may also be opened during operations for relieving atresia of the vagina.

The accident sometimes follows the criminal use of instruments by persons who are engaged in the nefarious practice of abortion.

Pressure of the foetal head is the most common cause of vesico-vaginal fistulae. My own inquiries into this subject lead me to believe that ninety per cent. of these lesions are to be attributed to this cause and occur in first labors. Denman long ago recognized pressure as a fruitful source of this affection. Simpson reiterates the same fact, and at the same time vindicates the forceps from the charge of producing the injury by saying that if the destruction of the septum were due to the employment of this instrument it would occur at once, whereas, as is generally known, it is only after several following labors that the opening appears. Smellie, Churchill, Hodge, Meigs, Penrose, Wilson, Sims, Bozeman, and others bear testimony to the same effect.

The manner in which the pressure acts, causing the destruction of a portion of the wall between the bladder and the vagina, is quite clear. The foetal head when engaged in the pelvis presses the anterior wall of the vagina against the posterior face of the pubic bones, and if from uterine inertia, or from a disproportion between the diameters of the pelvis and the head of the child, the latter is too long delayed in its passage, the vitality of the pinched or pressed tissues is destroyed, a slough in the course of from six to ten days drops out, and the fistula is established. The difference in the length of time between the labor and the formation of the unnatural opening depends on the intensity and the duration of the pressure. Thus, it may be merely sufficient to produce ulcerative perforation, or it may be so protracted as to

destroy the vitality of the parts and induce a slough. In the last condition the fistula will seldom be delayed beyond four or five days.

CLASSIFICATION.—There are three varieties of the fistula under consideration,—viz., *urethro-vaginal*, *vesico-vaginal*, and *vesico-utero-vaginal*. In the first the opening is in the posterior wall of the urethra; in a few cases the entire wall of the canal has disappeared.

In the second variety the fistula may be at the neck of the bladder, at its bas-fond, and in rare instances the septum is completely destroyed.

The relative frequency of the fistula, according to my own observation, is, first, at the trigone vesicæ, or neck of the bladder; secondly, at the bas-fond; thirdly, in the urethra.

In the third and least frequent variety the opening exists between the vagina, uterus, and bladder.

SHAPE, DIRECTION, AND SIZE.—The forms of vesico-vaginal fistula differ very much, being oval, round, or elliptical, running in a transverse, longitudinal, or oblique direction, and varying in size from an opening not larger than a quill to one involving the entire septum.

SYMPTOMS.—The recognition of a vesico-vaginal fistula is attended with little difficulty. If the patient is interrogated, it will be ascertained that there is a history of retention of urine following the labor, necessitating the use of the catheter, and that in a few days the urine was found to pass away involuntarily. The secretion, flowing over the nates, occasions excoriation, accompanied by pustules, while the vagina and the external genitalia are often found incrustated by the saline matter of the urine, a urinous odor constantly emanating from the clothing and person of the patient. It is only, however, by a physical exploration of the vagina that the existence of a fistula can be certainly determined. In order to make such an examination, the woman should be placed on her side, with the limbs drawn up, and the hips brought to the edge of the bed, opposite to a window with a good light. A Sims speculum being introduced into the vagina and the perineum drawn well back towards the sacrum, the canal will be so expanded by the air that the entire interior will be exposed to the eye, when the opening will probably be found, with perhaps a red, spongy mass, the mucous membrane of the bladder, protruding through it, and the urine escaping into the vagina. If any doubt exists, it can be removed by introducing a catheter through the urethra into the bladder and making it to appear in the vagina through the fistula; or a probe may be passed in the opposite direction from the vagina into the bladder. After an operation a fistula may be so nearly closed that only a very minute aperture remains, so small as to defy detection by a simple ocular inspection of the septum. In such a case the opening, however small, will readily be discovered by injecting the bladder with milk, the cavity of the vagina being exposed by the speculum during the operation. As the walls of the organ become distended, the milk will be seen to pass through the perforation and enter the vagina.

TREATMENT.—The treatment of vesico-vaginal fistula embraces the *preparation*, the *operation*, and the *after-management*.

PREPARATION.—The surgeon is rarely called to a case of this fistula until after the lapse of several weeks, and patients often suffer very much from neglect during the interval between the time of the accident and the operation, in consequence of the stillicidium of urine exciting inflammation, excoriation, and even ulceration of the hips, the thighs, and the external organs of generation. It is important, before any operation is attempted, that the health of the woman, if impaired, should be well established, for which purpose it will often be necessary to administer tonics, as tincture of sesquichloride of iron, at the same time attending to the state of the bowels and to securing fresh air and good food. The irritated and inflamed vagina should be washed twice a day with warm water containing a solution of permanganate of potash. The saline deposits can be readily removed by a very dilute wash of muriatic acid, while the excoriations are most expe-

ditionally healed by applying oxide of zinc ointment freely over the affected parts. Occasionally the fistula will require special attention preparatory to the formal operation. If the edges are very thin and pale, a condition unfavorable to union, they can be rendered thicker and more vascular by making slight incisions every three or four days along the margins, parallel with the long diameter of the opening, and rubbing into each a point of nitrate of silver. In a few instances, when great attention has been given to personal cleanliness of the parts, the fistula has healed spontaneously. No operation requires for its success greater attention to the general and local condition of the patient than that for the cure of vesico-vaginal fistula. It is rarely proper to attempt the closure of the opening earlier than from six to eight weeks after its occurrence. The time for the operation, when all other things are favorable, is three or four days after the catamenia have ceased. If done late in the month, it is likely to induce the discharge prematurely. The day immediately preceding that appointed for the operation the patient should have the bowels well opened by a gentle cathartic, followed after its action by a grain of opium or its equivalent in laudanum.

OPERATION.—Though a great number and variety of instruments have been devised by different operators for the closure of this fistula, I find the following answer every purpose: a stool or box covered with a blanket or comfortable, over which the patient is to be laid, on her breast; a Sims speculum (Fig. 1442), to expose the fistula; a pair of long, rat-toothed forceps, with a hook and a perforated adjuster at one end of the handle (Fig. 1443); two long knives to pare the edges of the opening (Fig. 1444); a needle-

FIG. 1442.



Sims speculum.

FIG. 1443.



Author's forceps.

FIG. 1444.



Knives for vesico-vaginal fistula.

FIG. 1445.



Needle-holder.

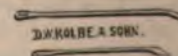
holder (Fig. 1445); a self-retaining catheter (Fig. 1446); a few needles (Fig. 1447), with countersunk eyes, in which to bury the silver wire, and which

FIG. 1446.



Self-retaining catheter.

FIG. 1447.



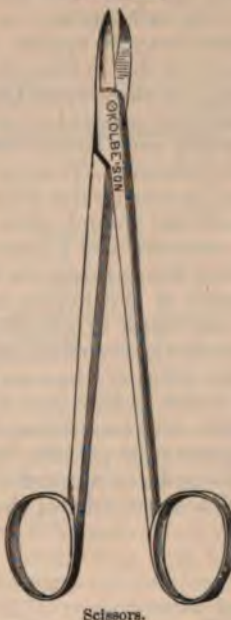
Needles.

should be carefully tempered, so that they will admit of being somewhat bent before they will break; a pair of long scissors, slightly curved on the flat (Fig. 1448); a few sponge-mops; a shot-perforator (Fig. 1449); perforated shot; and silver wire.

Assistants.—Four assistants are necessary for the convenient execution of the operation,—one to administer the anæsthetic, two to support the lower extremities (one of whom at the same time is to take charge of the speculum), and one to attend to sponging and to handing the instruments.

Bed.—The bed should be a firm mattress, protected by a piece of rubber- or oil-cloth, then a sheet, and next a folded sheet, on which the patient is to lie. Having removed the clothing, except a chemise and night-gown, the woman is placed under the influence of ether, and then laid, with the breast and abdomen downward, over the stool or box. Her head and shoulders must be supported on an inclined plane of pillows. Or, if the surgeon prefers, she may be placed on the side, with the limbs drawn up and the hips elevated. The former posture is the one which I prefer. The surgeon now, taking his seat behind the patient, introduces the lever-speculum into the vagina, and commits it to the care of one of the assistants supporting the limbs. (Fig. 1450.) Picking up the tissue at the circumference of the fistula with the forceps, the surgeon freshens the edges, taking care that the vivified surface shall be sufficiently wide, that is, from three-eighths to half an inch, and stopping just where the mucous membrane of the bladder and the border

FIG. 1448.



Scissors.

FIG. 1449.



Shot-perforator.

FIG. 1450.



Position, and speculum in place.

of the fistula join. This part of the operation is most expeditiously done by the knife, and may, at certain points, be aided by the use of the scissors. Sometimes the operator is annoyed by the repeated protrusion of the mucous membrane of the bladder through the opening, interfering with the process

of paring. This can be prevented by pressing a piece of sponge into the fistula until the cutting is completed. Unusual care is to be observed that at the angles of the fistula no point escapes the knife. The bleeding is seldom profuse, and generally soon ceases on the application of cold water thrown upon the raw surface in a continuous stream. If this is not sufficient, hot water may be applied in the same manner, or by a piece of lint or linen dipped in the boiling fluid and, the redundant liquid having been pressed out, applied directly to the bleeding part. If this does not succeed, the best course is to proceed at once to close the wound by the insertion of the stitches, which soon control the bleeding.

Introduction of sutures.—This, to one not practically familiar with the operation, is a task not unattended with difficulty. The first suture must be placed at the middle of the wound, after which those on either side are introduced. The distance between the stitches should be about three-sixteenths of an inch. In passing the sutures, the needle, threaded with silver wire, is placed within the grasp of the holder, and pushed through the lower lip of the wound, while the latter is being steadied by the forceps, entering the tissues half an inch from the denuded surface, and emerging at its upper margin. As soon as the point of the needle becomes distinctly visible, it should be seized by the needle-holder and drawn through. In the same manner the needle is made to traverse the upper side of the fistula; and, in order to prevent the soft parts from pushing before its point, the hook at the handle of the forceps should be placed against the tissues, so as to make counter-pressure. (Fig. 1451.) When the sides of the fistula are near together, the needle can be

FIG. 1451.



Passing the needle while counter-pressure is made.

made to traverse both at the same time. In passing the needle it must not be allowed to include the mucous membrane of the bladder, as such inclusion is liable to provoke vesical tenesmus. The stitch being completed, the ends of the wire are passed through one of the perforated shot, temporarily fastened by being twisted on themselves, and given into the care of one of

FIG. 1452.



Sutures introduced.

the assistants supporting the limbs, that the suture may be kept out of the way of the operator. The sutures being all placed in position (Fig. 1452), the operator proceeds to the adjustment.

The wire first introduced is to be separated from the others, its ends passed through the hole in the adjuster on the handle of the forceps, and as the latter is forced down the suture is drawn upon until the sides of the fistula are brought into accurate apposition, observing that no clot intervenes, when the shot can be clamped by the compressor. (Fig. 1453.)

Each suture having been treated in a similar manner, the ends are to be cut off close to the shot (Fig. 1454) when the operation will be completed.

The woman is next placed in bed, on her back, and the self-retaining catheter introduced into the bladder. That the bed-clothing and person of the patient

may be preserved dry, one end of a piece of light gum tubing should be passed over the extremity of the catheter, while the other is placed in a bottle, lodged in an opening made in the centre of the bed, below the hips. In the absence of this arrangement, a teacup or saucer can be placed under the end of the catheter to receive the urine.

SUBSEQUENT TREATMENT.—The success of an operation for vesico-vaginal fistula will depend very much on the after-management. The catheter will require to be watched, in order that no impediment to

the flow of the urine shall exist. There should always be two instruments on hand, so that on removing one the other can immediately be introduced into the bladder. For the first twenty-four hours it may be necessary to make the change three or four times, on account of the passage of small coagulæ of blood; but after this period twice will be sufficient,—once in the morning and once in the evening. The position on the back is that best adapted to the successful drainage of the bladder, as well as to the comfort of the patient. The bowels are to be kept quiet for the first four days, and for this object, together with that of relieving any nervous restlessness incident to the restraints of the bed, half a grain or a grain of opium may be administered morning and evening. On the evening of the fourth day a gentle laxative may be given, after which the anodyne is to be suspended during the rest of the treatment, unless specially required on account of some accidental pain. Sleeplessness is best provided against by bromide of potassium. Should the patient suffer from spasms of the bladder, causing the catheter to be expelled, or should there occur rectal tenesmus, a suppository of opium or an enema of laudanum will quiet the vesical or intestinal irritability. Flatulent distention of the bowels is best relieved by turpentine, or by aromatic spirit of ammonia, with a little tincture of cardamom.

Diet.—For the first four days the diet should consist of milk and beef-tea; after that more solid food, and a greater variety, may be allowed, as eggs, cream-toast, broth, fresh meats, coffee, and tea.

Removal of sutures.—On the seventh or eighth day following the operation the stitches are to be removed, and for this purpose the position on the side, across the bed, and with the limbs drawn up, will answer. Generally it will not be necessary to administer anæsthetics, as little pain will be experienced. In nervous, timid patients a few inhalations may be given to obtund sensibility while the wires are clipped and drawn away. In cutting and withdrawing the stitches, the cavity of the vagina is to be exposed by the Sims speculum. Any mucus which obscures a proper view of the parts is to be mopped away, after which the surgeon, seizing one of the shot with the long forceps, holds it fixed, while the wire is cut on one side with the scissors, at the same time straightening the hooked end of the thread. After this preliminary measure the blades of the closed scissors are to be placed against the loop on the opposite side, when by drawing on the shot the wire will be made, during its removal, to revolve about the instrument as a fixed point. (Fig 1455.) This manœuvre, so easy of execution, will not only prevent a possible laceration of the cicatrix, but will also cause the patient little or no pain.

FIG. 1453.



Shot-compressor.

FIG. 1454.



Wound closed, shot clamped, and ends of wire cut off.

The sutures being removed, the patient must be returned to her original position in bed, and the catheter again inserted. It will not be proper to dispense with the use of this instrument, or to allow the woman to sit up, for at least four or five days after the stitches have been taken away, as the cicatrix might open if the bladder was allowed to become distended with urine. Even after both bed and catheter have been relinquished, I insist on the patient emptying the bladder for a few days at shorter intervals than would be her custom in health.

FIG. 1455.



The shot and loop of wire after removal.

If, on withdrawing the sutures, it is found that a small point of the fistula remains unhealed, let it be immediately refreshed, and again closed by suture, and the treatment continued as in the first instance. When a large opening remains, no operation will be proper at an earlier period than six or eight weeks.

Failure will occasionally follow the operation for vesico-vaginal fistula, and when it does it can generally be traced to insufficient denudation or inaccurate apposition; to the edges of the fistula being thin, unyielding, and defective in vascularity; to an abnormal softness of the tissues unfavorable to holding the sutures; or, finally, to some imperfection in the general health inimical to the work of repair. Whatever may be the explanation of the miscarriage of the operation, the surgeon is not to be discouraged. The disqualification must be corrected, and the work of closing the fistula renewed until his efforts are crowned with success.

SEQUELS.—It may happen, when a fistula situated at the neck of the bladder has been successfully treated, that a certain degree of incontinence follows. This may be due to a loss of power in the sphincter vesicæ, or may be a consequence of too much traction on the lower wall of the urethra, producing a patulous state of the meatus. Time alone can correct this defect, by the general elongation of the shortened tissues. Simon, in the treatment of vesico-vaginal fistula, does not deem the metallic suture, the catheter, or the recumbent position necessary. Without attempting any other criticism of this statement, I shall only say that the plan advocated by the learned professor at Heidelberg is not adapted to American women.

COMPLICATIONS.—A vesico-vaginal fistula may be complicated by location, extent, and structure. When situated high, near the insertion of the vagina, and posterior to the neck of the uterus, its closure can be effected only by attaching the lower margin of the opening to the posterior lip of the cervix uteri, or by turning the cervix into the bladder and stitching the inferior border of the fistula to its anterior semi-circumference. When I have been

FIG. 1456.



Destruction of almost the entire vesico-vaginal septum.

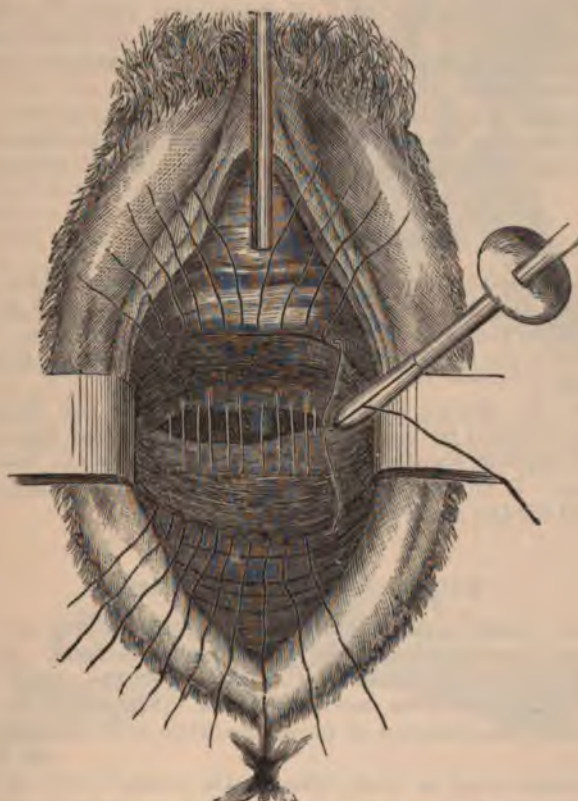
compelled to adopt the latter course, no inconvenience followed the presence of the menstrual fluid, which was passed through the bladder. The operation, in other respects, does not differ from that practiced in fistulae lower down in the vagina.

In some very unfortunate cases almost the entire vesico-vaginal septum sloughs away.

(Fig. 1456.) In this sad state two operations have been performed with a view to give relief, namely, episiorrhaphy and kolpoplexis. The first consists in

closing up the external opening of the vagina by freshening and uniting together the labia majora, an operation devised by Vidal de Cassis, and which generally leaves a small opening immediately below the urethra, through which the urine trickles away. The other operation, or that of kolpoplekisis, introduced by Professor Simon, aims at uniting the posterior wall of the vagina to whatever may remain of the vesico-vaginal septum. (Fig. 1457.) The effect of the urine on the vagina is always prejudicial to its

FIG. 1457.



Closing up the vagina; edges pared and sutures introduced.

structures. The evils which follow these procedures are greater than those which the operation proposes to overcome. A resort to either method can rarely be required. A much better plan of providing for these unfortunate cases is that of Bozeman, by which the uterus is gradually drawn sufficiently far down to admit of the anterior or posterior lip of the cervix being denuded and united by sutures to what remains of the septum between the bladder and the vagina, and closing the opening. Bringing the womb down for this purpose cannot be done at once; it will require that the traction be applied daily, until the tissues stretch sufficiently for the purpose in view, and often success is reached only after the knife has been applied to opposing bands of cicatricial tissue.

Utero-Vesical Fistula.

In the production of a utero-vesical fistula there are two factors: *first*, the vesico-vaginal septum at the insertion of the vagina on the neck of the uterus has been subjected to long-continued and severe pressure against the pubes

by the foetal head, the effect of which is to produce a circumscribed slough; and, *secondly*, as has been shown by Emmett, a laceration of the cervix has taken place, which heals up spontaneously, with the exception of that part opposite the damaged part of the bladder.

TREATMENT.—To obliterate a defect of the above nature, the anterior lip of the uterine neck should be slit up to the fistula with a pair of long scissors, while the parts are steadied by a tenaculum or hook. In order that the edges of the fistula may be vivified and advantageously shaped for approximation, the first incision should be joined by two diverging cuts at its upper extremity, thus excising a portion of the uterine tissue, leaving a wound resembling the letter Y. The gap is to be closed by silver sutures, which are to be secured by the shot-clamp and allowed to remain undisturbed for six or seven days before being removed.

When the fistulous opening is too high in the neck to admit of being thus treated, there remains no alternative but to freshen and close up the lower part of the canal of the cervix by sutures, thus turning the menses into the bladder.

Vesico-Utero-Vaginal Fistula.

In *vesico-utero-vaginal* fistula the opening into the bladder occurs near the insertion of the attachment of the vagina to the neck of the uterus, and is produced in the same manner as the *utero-vesical* fistula. Occasionally the anterior lip of the cervix is lost by sloughing, in common with the vesico-vaginal septum.

TREATMENT.—In closing a fistula of this kind, the one lip of the cervix uteri must be utilized by being freshened and attached by sutures to the vesico-vaginal septum, similarly denuded, which forms the lower boundary of the opening. If the anterior lip of the neck has been lost, the posterior lip can be used for the same purpose.

Surgical Affections of the Uterus.

PRELIMINARY OBSERVATIONS.—In examining the uterus the practitioner resorts to both the digital and the instrumental method. By means of a digital exploration, or the "touch," the position of the organ, its mobility, alterations in the size, form, sensibility, and structure of the os and the cervix, and often the existence of fibroid growths or of other tumors, can be ascertained.

The examination may be made either in the recumbent or in the standing posture. When the former is selected, it can be practiced with the woman either on the side or on the back. If on the side, the limbs should be drawn up and the hips brought close to the side of the bed. If the dorsal decubitus, which is the best, is preferred, the limbs should also be flexed. The hands of the practitioner having been well washed and the nails thoroughly cleaned, he takes his seat by the side of the bed, and, passing his hand beneath the clothing, introduces the index finger, previously well smeared with olive oil or cold cream, into the vagina, the other fingers with the thumb being strongly flexed so as to avoid contact with the genitalia, and, carrying it in different directions, acquires such information as may be desired. The more gentle and light the touch of the finger, the more satisfactory will be the information gained.

By making simultaneous pressure over the abdomen immediately above the pubes, while the finger is in contact with the cervix uteri (Fig. 1458), a correct idea can be formed of the size of the womb, its position, and the existence of any growths in its walls.

Valuable information can also be acquired by a digital examination made through the rectum. In retroversion the fundus of the uterus will be felt encroaching upon the bowel, and fibromata, when seated in the posterior

wall of the organ, may be readily detected, as also may any enlargements of the ovaries. There should be in these examinations no exposure whatever of the person of the female.

When the "touch" is employed in the standing posture of the patient, the physician kneels on one knee by the side of the woman and passes the hand beneath the clothing and in front of the thighs. Though it is sometimes possible to form a more just appreciation of the exact situation of the uterus when the examination is made in this way, the position is one so mortifying and repugnant to the feelings of a lady of ordinary delicacy and sensibility, that, unless a matter of absolute necessity, it should never be insisted upon.

Instrumental examination.—Not only is it necessary to feel, but in many cases to see also the interior of the vagina and the neck of the uterus. For the latter purpose the speculum is employed. There are three varieties of the instrument, which answer any purposes,—the Sims or duck-bill (see Fig. 1442), the bivalve (Fig. 1459), and the cylinder speculum (Fig. 1460).

FIG. 1458.



Simultaneous abdominal and vaginal examination.

FIG. 1459.



Bivalve speculum.

The *Sims speculum* is an indispensable instrument in the operation of vesico-vaginal fistula. The *bivalve speculum* has undergone various modifications.

FIG. 1460.



Cylinder speculum.

The best is that in which two movements of the blades can be made,—the one an oblique and the other a parallel separation.

The *cylinder speculum* is constructed generally of glass or hard rubber. The latter material is much the safer. Two or three sizes should be on hand.

In addition to the speculum it is necessary in many cases to employ a uterine sound (Fig. 1461), by which displacements can be corrected, the depth of the

FIG. 1461.



Uterine sounds or probes.

uterus determined (there being a scale marked on its surface), and growths in its cavity discovered. The instrument is made of steel, copper, or German silver, the two last materials being generally the best, as the curve can be altered at pleasure to suit different cases.

Use of the speculum.—In using the Sims speculum the patient must be either on the hands and knees across the bed, or on the left side, with the limbs well drawn up, the body rolled over on the breast, and the left arm drawn back behind the body. When the examination is made with the bivalve or the cylindrical instrument, the most convenient position is that on the back across the bed, with the nates projecting over its sides and with the limbs flexed and separated and resting on a stool or chair or supported by an assistant, or the woman may possibly be able, by planting her feet on the edge of the bed, to dispense with any other support. A sheet is to be placed over the patient and the undergarments raised. The physician now passes the speculum, properly greased, underneath the clothing into the vagina, guided by the sense of touch, when the sheet should be tucked in around the limbs and the instrument in a way to leave no part of the genitalia exposed. If the light is properly directed through the speculum into the vagina, any erosion, congestion, or granulation of the neck, or any discharge from its canal which may be present, will be exposed to view.

The sound or probe can be introduced into the uterus either on the finger as a guide, with the patient on her back and her limbs drawn up, or through the speculum, when that instrument is used. The utmost gentleness and tact are necessary in employing the sound. Force is not allowable; and if it does not pass readily, it will be due either to a defective curve of the instrument, which must be changed, or to some mechanical obstruction in the canal of the cervix or the cavity of the uterus.

Sometimes it becomes necessary to fix the womb or to draw it down during

FIG. 1462.



Hook for the neck of the uterus.

FIG. 1463.

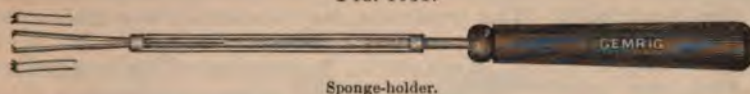


Claw-toothed forceps.

manipulation, which can be most satisfactorily done by sinking into its neck a hook (Fig. 1462) or a pair of claw-toothed forceps. (Fig. 1463.)

Mops for cleansing or swabbing out the neck of the uterus or the vagina are

FIG. 1464.



readily made by fastening bits of soft sponge between the blades of a holder. (Fig. 1464.)

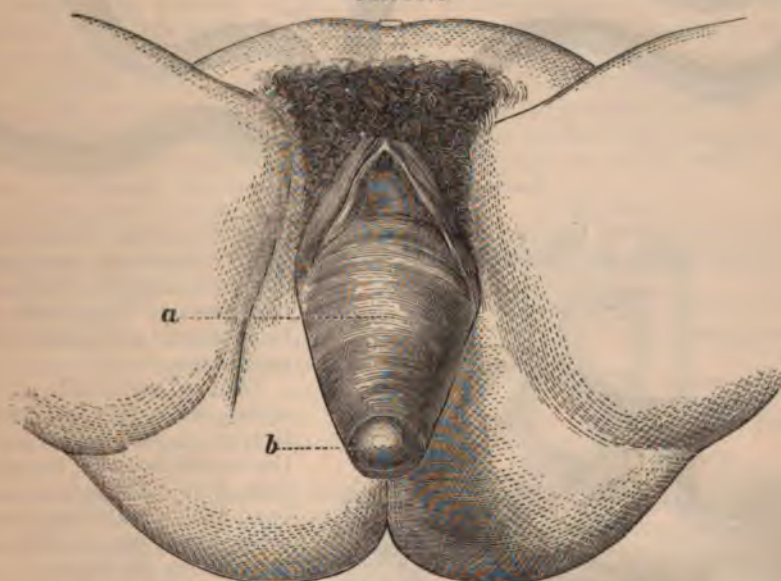
Malpositions.

The uterus may be displaced downward, forward, backward, or laterally.

Procidentia Uteri, or displacement of the uterus downward, arises from the weight of the uterus being increased by engorgement of the organ, or by hypertrophy of its neck; from lacerations of the perineum, which permit also protrusions of the posterior wall of the vagina; from relaxation of the utero-sacral ligaments; and from tumors, abdominal or pelvic, which crowd the organ downward. I believe a large number of the cases of prolapsus arise from women getting up too soon after labor. The degree of displacement varies in different cases, from a very slight sinking of the uterus to its complete extrusion (Fig. 1465) through the vulva, attended necessarily by inversion of the vagina.

SYMPTOMS.—Prolapsus of the uterus is accompanied by a sense of weight

FIG. 1465.



Extreme degree of procidentia uteri: a, anterior wall of vagina; b, os uteri.

in the pelvis, with dragging sensations about the hips and pain in the lumbar region, especially when the patient is standing or walking. The displacement not unfrequently produces more or less vesical irritation from the traction exerted on the bladder, and if of long duration occasions disorder of the digestive and nervous systems. By the "touch" the displacement is readily recognized.

TREATMENT.—The management of a case of prolapsus uteri is often a matter of great difficulty. Unfortunately, the mechanical measures which

are so generally in use, while they give a temporary support to the womb, tend to enlarge the capacity of the vagina, which of itself constitutes a determining cause of the displacement; and yet in a large number of cases no other plan is advisable. The treatment may be divided into the *mechanical*, the *medical*, and the *operative*.

FIG. 1466.



Meigs's ring pessary.

MECHANICAL TREATMENT.—This consists in placing a prop or pillar of support between the neck of the uterus and the perineum. This is done by means of pessaries, of which there are several patterns, some globular, some rings (Fig. 1466), and others oblong, lever-, and stem-shaped. These pessaries are made of glass, metal, hard rubber, and soft rubber. The pessary in general use, and the least objectionable one of all, is that devised by the late Professor Hodge (Fig. 1467), or one of its modifications. The large extremity of this instrument is placed in the utero-vaginal notch behind the neck of the womb, with its convexity downward, the small extremity behind the arch of the pubes and below the urethra. (Fig. 1468.)

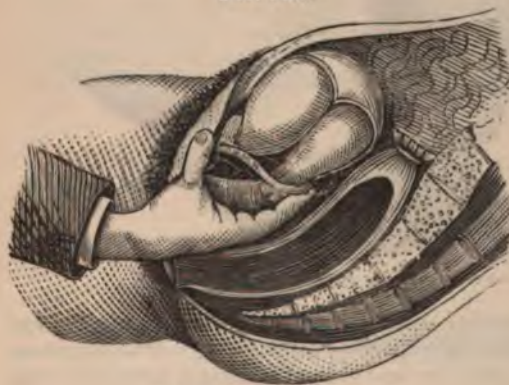
FIG. 1467.



Two varieties of Hodge's lever pessary.

When the floor of the perineum has been damaged, or the dilatation of the vagina is so great that the lever pessary is not retained, and the uterus descends into the vulva, the cup pessary (Fig. 1469) can be substituted for a time with advantage.

FIG. 1468.



Adjusting the lever pessary.

The os and neck of the womb, when this instrument is applied, rest in the cup at the end of the stem, the latter being supported by a perineal band, which is attached to another band, surrounding the body above the hips.

When the uterus is lifted into place its weight rapidly diminishes, whether it has been the result of passive engorgement or of cervical hypertrophy.

MEDICAL TREATMENT.—At the same time that mechanical supports are being employed, much good can be done by astringent vaginal injections. Among these none appear to fulfill the indications of securing cleanliness and causing a tonic contraction of the

canal better than a strong decoction of oak bark or of alum, which should be used daily. If the general system of the patient is weak, the administration of tonics, as quinine, nuxvomica, and iron, will prove beneficial.

OPERATIVE MEASURES.—When the procidentia follows a laceration of the perineum, little relief can be looked for until the latter has been restored by an operation.

With a view of sustaining the uterus by getting rid of redundant vaginal tissues, several operations have been devised. For the suggestion of these the profession is indebted to Marshall Hall, though he himself, I believe, never carried his plans into effect.

Dr. Sims, in 1858, first gave to this method a practical trial by making a V-shaped denudation on the anterior wall of the vagina, the apex of the V being situated at the neck of the bladder, and the two freshened strips, which diverged as they ascended, terminating one on either side of the vagina a little below the neck of the uterus. Interrupted silver sutures were then passed across, and these surfaces brought together and secured in the median line. This operation I have done a number of times, but with only partial success. It is, however, one which is somewhat difficult to perform, and has been replaced by another, which is easier of execution and more efficient in its results. In this method, while the uterus is pushed by a sponge probang up into the posterior cul-de-sac, the mucous membrane of the vagina is denuded at three distinct points,—one, the largest, transversely in front of the neck of the uterus, and one on each side, just at the extremities of the first, and joining at the neck of the bladder. These surfaces are brought into contact with one another just in front of the cervix by a silver suture, thus fixing the uterus in the fold or collar made from the vagina. (Fig. 1470.) The lateral branches of denudation are then closed by silver sutures, four or five in number to the inch. The stitches are to be removed from the eighth to the tenth day. During the treatment the bladder is to be kept empty by periodical catheterization, or by the continuous retention of Sims's catheter.

Emmett, instead of making one line of denudation across the vagina below the cervix, makes three vivified surfaces, one on each side of the neck of the womb, and the third between the lateral ones, each separated from the other by the mucous membrane of the vagina. The three raw surfaces are then brought together by sutures.

Another plan is sometimes adopted, of freshening the greater labia and uniting them well forward by sutures, so as to offer an obstacle at the vulva to the escape of the prolapsed uterus. This will frequently succeed when other measures fail; but it should be a last resort.

Retroversion.—In this displacement the fundus of the uterus falls backward and downward in various degrees, from the slightest posterior inclina-

FIG. 1469.



Cup pessary.

FIG. 1470.



Form of the denuded surface, with the sutures introduced, in the operation for prolapsus of the uterus.

tion to that in which the organ reaches the hollow of the sacrum. The neck is turned towards the pubes. (Fig. 1471.) It occurs both in the unimpregnated and in the pregnant

FIG. 1471.



Slight retroversion of the uterus.

uterus, and is sometimes bound down in its unnatural position by adhesions. The causes producing retroversion are vascular engorgement, the existence of a fibroid, either in the posterior or in the anterior wall of the organ, and overdistention of the bladder.

The signs of the displacement are fullness and weight in the pelvis, with dragging lumbar and sacral pains, accompanied by a frequent desire to micturate, especially when prolapsus is also present, the bladder being then drawn or dragged upon. There is experienced frequently some little difficulty in defecation, owing to the pressure of the body of the uterus upon the rectum. A digital examination made through the latter intestine will enable the physician to detect the fundus of the womb encroaching upon the bowel; by the vaginal touch he may recognize the os directed towards the pubes.

Retroversion may provoke dysmenorrhœa, inflammation of the bladder, or congestion of the rectum, and may also cause sterility. Even the loss of locomotion may follow this displacement, from pressure on the sacral plexus of nerves.

TREATMENT.—Unless tied down by adhesions, the uterus should be immediately replaced, as the longer it is allowed to remain retroverted the greater will be the difficulty of keeping it in its normal position. When the retroversion occurs in the impregnated organ, the necessity for its reduction is urgent, as it may, if neglected, provoke miscarriage, or the womb may become so impacted under the promontory of the sacrum by the development of the fœtus as to render all efforts for the purpose unavailing. Early reductions are also of prime importance when a fibroid growth located in the walls of the organ has occasioned the displacement, as morbid processes are intensified by all causes favoring uterine congestion, of which retroversion is one. In replacing a retroverted uterus the patient should be put in one of two positions,—either on her back with the limbs drawn up and the pelvis elevated, or on her knees and breast with the hips raised. Upon raising the hips the intestines gravitate away from the pelvis, and thus leave measurably vacant the anterior utero-vesical space. A sound or a repositor (Fig. 1472) now being

FIG. 1472.



Sims's elevator, or repositor.

passed into the uterus (Fig. 1473) and used as a lever, the organ can, in recent cases, be readily raised into place (Fig. 1474), after which a lever pessary must be immediately adjusted, in order to prevent a recurrence of the displacement. The patient will do well to remain in the recumbent position for

twenty-four hours after the adjustment, as the tendency of the organ to topple over again is greatly diminished by rest. To prevent a recurrence of the

FIG. 1473.



Repositor introduced into the uterus preparatory to replacing it.

displacement, a Hodge pessary as modified by Dr. Albert Smith should be introduced before the patient is allowed to rise from the bed.

FIG. 1474.



Uterus raised into position by repositor.

When the retroversion has existed for some length of time, and when adhesions have formed so as to tie the uterus down, the restoration can only be effected gradually, by elongating the inflammatory bands by pessaries of different lengths, using first a short one and by degrees longer ones as the adhesions yield, until finally the difficulties are surmounted. Forcible attempts to burst the checks arising from inflammatory attachments are not without danger, as they may give rise to a pelvic cellulitis vastly more to be deprecated than the condition which they are designed to rectify. Whenever, therefore, severe pain is complained of, it will be better to discontinue for the time all efforts to correct the retroversion, or else to adopt gentler measures.

When the knee-and-breast position is adopted,—one which I have frequently called to my aid both in cases of obstinate retroversion arising from ordinary causes and in those caused by fibroids,—the woman is placed on her knees, the chest resting on the folded arms, and the hips being well

raised. In this posture the viscera gravitate towards the diaphragm, when a finger introduced either into the vagina or into the rectum and pressed against the fundus of the uterus will usually cause it to resume the proper position. Should this not follow, the same posture is admirably adapted for the application of the repositor.

Professor Campbell, of Georgia,* as early as 1875 called the attention of the profession to the value of posture, associated with pneumatic pressure, in correcting uterine displacements. Several very important directions are

FIG. 1475.



Genu-pectoral position.

given in connection with this plan, particularly with reference to the character of the curvature of the spine, which should be deeply concave instead of being convex. (Fig. 1475.) In this position, if the vagina is opened, the intruding air expanding the canal will, with the gravitation of the viscera, induce a spontaneous correction of the displacement. The

woman, by adopting this plan, has the remedy in a great measure in her own hands.

The colpeurynter passed well up into the vagina and distended either with air or with water is occasionally resorted to for overcoming a retroversion: as the bag enlarges, the womb is pushed up out of the hollow of the sacrum.

A difficulty sometimes encountered in reducing retroversions by the finger alone, is to make the fundus of the uterus clear the promontory of the sacrum. This may require digital pressure made through the rectum, or it can be overcome by adopting the plan practiced by Emmett, which is to sink a hook into the neck of the uterus, drawing it down towards the outlet of the vagina, while at the same time a finger is passed up behind the body of the organ and the latter pressed forward towards the pubes.

Alexander, of Liverpool, has devised an operation for correcting obstinate cases of retroflexion by cutting down on the external abdominal rings, isolating and shortening the round ligaments after restoring the uterus to its proper position, and stitching them to the pillars of the rings. The operation is rarely required.

Anteversion.—In anteversion the fundus of the womb is carried forward towards the pubes, and the os backward towards the hollow of the sacrum. (Fig. 1476.) The displacement as compared with retroversion is quite infrequent.

The causes which determine anteversion are hypertrophy of the body of the womb, pelvic tumors, false bands (the product of a pre-existing peritonitis), tight lacing, cystocele, etc.

Very little inconvenience attends the displacement, unless it is accompanied by prolapsus, when the drag on the bladder is prone to provoke a cystitis. Anteversion is sometimes attended with a certain degree of pelvic discomfort analogous to that produced by retroversion.

Very positive information is revealed by the "touch" when the neck of the womb is felt far back towards the sacrum.

TREATMENT.—Unless the symptoms are urgent, little interference is required in cases of anteversion. Indeed, the displacement is much less amena-

* *Résumé of a Report on Position and Pneumatic Pressure and Mechanical Appliances in Uterine Displacements, 1876.*

ble to correction by mechanical means than is retroversion. If the woman has a pendulous belly, or is at all given to corpulency, the use of an abdominal supporter will constitute a valuable auxiliary in the treatment, by sustaining, to some extent, the weight of the intestines. I have seen many patients derive quite as great comfort from a properly-adjusted abdominal supporter as from any intra-vaginal supporter.

A lever pessary similar to that employed in cases of retroversion, with its upper end behind the cervix uteri, will often give relief simply by raising the womb, notwithstanding that the tendency of the support is to increase the anteversion. All tight lacing should be abandoned. Thomas's anteversion pessary (Fig. 1477) will frequently be found to afford the greatest relief.

FIG. 1476.



Anteversion of the uterus.

FIG. 1477.



Thomas's anteversion pessary.

Women should be taught to remove and replace their pessaries. The possession of this kind of tact will administer greatly to their comfort and safety.

When the vesical irritation becomes so great as constantly to harass and render miserable the patient, two courses are open to the surgeon,—elytrorrhaphy or cystotomy. The first consists in denuding transversely two strips on the anterior wall of the vagina, the upper one in close proximity to the neck of the uterus, and the other about one inch lower down, and uniting the raw surfaces by silver sutures.

It is contemplated in this operation to drag the neck of the uterus forward by diminishing the length of the vagina, and in this manner carry the body of the womb backward. The procedure is not a very successful one.

Cystotomy, which has been advised, aims at placing the bladder at rest, with a view of controlling the cystitis caused by the drag on the bladder.

The operation is performed by making an opening into the bladder behind its neck, through the vagina, and allowing the water to drain away through the latter canal. It has been frequently done, but only with partial success. Even after such a fistula is established, it will be necessary to use a pessary to raise the womb; otherwise the vesical irritation will continue unabated.

Uterine Flexions.

Flexions of the body and of the neck of the uterus are met with in both married and unmarried women, in the sterile and in the fruitful. That of the neck is very much the more common. In unmarried women the flexion is developed about the period of puberty, the bend occurring at the point where the vagina is inserted on the neck of the womb. Uterine flexions are as varied as the *versions*. The two most commonly encountered are *ante-*

flexion (Fig. 1478) and *retroflexion*. (Fig. 1479.) In the former the cervix is

FIG. 1478.



Anteflexion of the uterus.

FIG. 1479.



Retroflexion of the uterus.

bent forward at a more or less acute angle with the body of the womb. In the latter the flexion is sometimes the result of a retroversion.

The cause of flexions at this period of life is believed to be an asymmetrical development of the cervix and the body of the uterus, probably from changes induced by conformity to modern modes of life.

When the flexion makes its appearance later in life and in married women, it may be referred to inflammatory changes affecting the submucous connective tissue of the cervix, and produced by difficult labor, or by abortions, criminal or otherwise.

Some writers, and with great plausibility, attribute these flexions to the unequal tonicities or contractility of the superficial and deep portions of the longitudinal muscular fibres of the organ.

When occurring in the unmarried, they are often due to the effects of cold, especially cold taken during menstruation. Lateral flexions have in most cases an inflammatory origin.

The evils which follow uterine flexions are dysmenorrhœa and often sterility.

The diagnosis of uterine flexions is readily established by a digital examination, by which the deviation of the womb from the proper position, and the bend at the junction of the cervix and the body of the uterus, can be detected.

TREATMENT.—The existence alone of a slight cervical flexion is no reason for instituting treatment. It does not follow that all women with flexions are doomed either to painful menstruation or to sterility. Many, indeed, escape both, and young women who realize considerable pain at the beginning of a "period," or even for two or three days during its progress, will, after marriage, menstruate without suffering. It is only, therefore, when dysmenorrhœa is severe and persistent, or when the sterility seems to be pronounced, that surgical interference is to be advised. When the flexion is posterior and only the outcome of a retroversion, it can in a good measure be corrected by raising the womb from the hollow of the sacrum and supporting it on a pessary.

In acute flexion, and also in the other varieties, sponge tents and dilating instruments have been introduced through the canal of the cervix into the cavity of the uterus, with a view of removing the deviation by straightening the neck, and often with considerable correcting influence.

Something will be gained by the use of an anteversion pessary like

Thomas's, aided by an abdominal supporter, at the same time preventing fecal accumulation in the lower part of the large intestine, and educating the bladder to retain for some time the urine, so as to secure by the distention of its walls some pressure against the anterior wall of the uterus. The stem pessary was at one time in popular use for the purpose of correcting these flexions; but the evils which have so often followed its employment have most properly caused its condemnation.

Professor Campbell uses with success a form of the pessary which removes some of the objections that have been urged against the old instrument, and which he calls the soft rubber spring stem pessary. It consists of three parts,—a spring of any required strength, a piece of india-rubber tubing, which is to be slipped over the spring, and an appliance for introducing and adjusting the instrument. (Fig. 1480.) Before inserting the pessary its

FIG. 1480.



Campbell's soft rubber spring stem pessary.

author prepares the canal of the cervix uteri for its passage by introducing for a short time a sponge tent curved sufficiently to admit of its entering the womb without inflicting any violence upon its lining membrane. The stimulus imparted to the muscular fibres of the uterus, the relaxed condition of which, according to the theory of Eiklund and Martin, constitutes the cause of the flexion, is influential in exciting those contractions which are necessary to the permanent cure of the distortion.

Dr. Elwood Wilson relies very much for correcting flexions on introducing his dilator into the uterus and straightening the angle by forcibly separating the blades of the instrument. The longitudinal muscular fibres on the anterior face of the flexion are by this process overstretched and paralyzed, thus giving the deep fibres an opportunity to recover their power and prevent a recurrence of the curvature of the cervix.

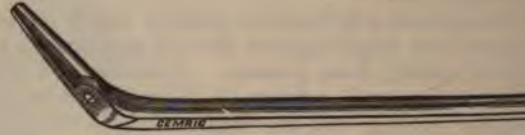
The operation which has been devised for removing the evils of an invincible flexion is the division of the cervix uteri, including the internal os, so as to convert a curved into a straight canal. Some prefer the bilateral section introduced by Sir James Simpson, and advocated, I believe, also by Sims. Others, as Emmett, confine the incision to the posterior lip. The bilateral method is more likely to be followed by profuse bleeding; at least such has been my experience. There is also danger of transcending the limits of the vagina and exposing the cellular tissue of the pelvis; and, even when no such accidents follow, it possesses no advantage over the section of the posterior part of the cervix.

In dividing the posterior part of the neck, the patient is to be placed on the left side, with the hips projecting over the side of the bed, the uterus being exposed by introducing a Sims speculum into the vagina and drawing the perineum back. The operator sinks a long tenaculum into the anterior lip of the cervix, and drags the uterus well forward with one hand, while with the other he introduces one blade (the *blunt-pointed* one) of a pair of curved scissors (Fig. 1481) into the canal of the cervix, and the other along its posterior surface in the median line, and up to the insertion of the vagina; then, by closing the blades, the intermediate tissue of the neck will be divided. As there generally remains a small portion of uterine structure at the in-

ternal os which escapes the scissors, it should be (Fig. 1482.)

A sound must now be passed into the womb, and freely laid open: if this is the case, a roll of absorbent

FIG. 1481.



Scissors for dividing the neck of the vagina.

glycerin is to be introduced into the canal and behind the neck, and allowed to remain until loosened.

FIG. 1482.



Uterotome.

should be replaced by another pledget of the same material. If the discharge continues to be profuse, the vagina must be tamponed with lint previously treated with a dilute solution of potassium permanganate and absorbent cotton. A suppository containing two grains of iodoform should be administered, and the patient placed in bed. The patient should rest in forty-eight hours, unless much uneasiness is experienced. A few strips nearest the outlet of the vagina may be removed. In two weeks the woman may be allowed to rise. Life should be enjoined for at least an additional year. The patient should not be advised unless the evils resulting are considerable, and until other less dangerous measures have been exhausted.

Lateral Flexions.—The principle which governs the treatment of lateral and posterior flexions should be applied to the treatment of lateral flexions.

Laceration of the Cervix

This accident, first described by Dr. Emmett, is exceedingly common, occurring, according to the statistics, 32.80 per cent. of all women coming under his observation, and who have had children.

Laceration is liable to follow tedious or protracted labor, particularly in cases requiring the use of the forceps. The lacerations of the lips of the cervix, the anterior being the more common, are usually accompanied and followed by unhealed lacerations are followed by vaginal fistula, erosion or ulceration and hypertrophy of the cervix, procidentia, endometritis, and derangement of the general health, in bad cases of laceration, but in good cases the patient is pale, nervous, dyspeptic, and has general and pelvic pains.

To detect a laceration it will be proper to make

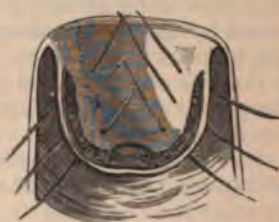
ocular examination. When the finger is passed over the cervix anteriorly and posteriorly, it will be found to be greatly hypertrophied, sometimes exceeding in size the body of the uterus. The os will be found to be quite patulous. It is also possible, as the lips of the laceration are everted, by a delicate use of the touch to discover a notch or depression marking the line of the tear.

When the parts are exposed by the speculum, and the two lips of the cervix are approximated by the tenaculum, the everted parts will turn inward towards the canal.

TREATMENT.—Lacerations of the cervix, unless accompanied by much local distress or structural alteration, do not demand surgical interference. The thickening and unhealthy granulations of the lips of the fissure will be greatly improved by daily vaginal injections of warm water, and by painting the parts semi-weekly with Lugol's solution of iodine, or with tannin and glycerin. Should the follicles of the cervix undergo cystic degeneration, the cysts ought to be evacuated by punctures before the iodine is applied. When the case is deemed sufficiently grave for an operation, the first aim should be to secure the subsidence of all tenderness on pressure against the surrounding parts. To operate before this has disappeared is to subject the woman to the danger of an acute cellulitis.

In executing the operation, the patient can be placed either on the left side or on the breast, the parts being exposed by the Sims speculum. While the lips are drawn forward and steadied by a tenaculum, the operator, either with a sharp bistoury or with scissors, pares away the edges of the cleft, forming as broad a denuded surface as possible. Care is to be taken also that the parts shall be scarified at the upper angle of the fissure, at which point, however (if at the juncture of the body and neck), the freshening should not be carried to any depth, for fear of wounding the cervical artery. If the bleeding is profuse, which, in the spongy condition of the neck, is not unlikely, hot water should be thrown upon the parts in a stream from a syringe. If this fails to arrest the flow, it may be necessary to pass a wire noose around the base of the neck, close up to the insertion of the vagina, and twist it until the vessels are constricted. The same end can be accomplished by the single canula and wire. The denudation having been completed, the opposed surfaces are to be accurately approximated by a sufficient number of silver sutures, secured either by the shot-clamp or by twisting. The ends of the sutures are next to be cut off close and the patient placed in bed, where she should remain for at least two weeks after the removal of the stitches. (Fig. 1483.) The urine may be drawn by the catheter, or it may be passed into the bed-pan, as it is not likely to come in contact with the wound of the cervix. The vagina during the treatment should be washed out with warm water daily, as soon as any secretions are discovered in the canal. The diet, at first consisting of milk and animal broths, may, after the first three days, be increased to bread, eggs, and a moderate amount of meat. From the seventh to the ninth day the stitches are to be removed, the uppermost one first. If union has not taken place at this point, the others must be allowed to remain longer, so that the gap at the upper angle may have time to granulate and heal.

FIG. 1483.



Laceration freshened and sutures introduced.

Inversion of the Uterus.

The term *inversion of the uterus* is used to express the turning of the womb inside out, the internal becoming the external, and the external the internal surface. The inversion may be either *partial* or *complete*. The nature of the

accident was understood as early as the time of Ambrose Paré. In partial or incomplete inversion the fundus of the organ has not passed the limits of the os, while in the complete variety it has not only escaped through the os, but also protrudes into the vagina, or is even placed exterior to the vulva, between the thighs. The accident is quite uncommon. In 140,000 labors occurring in two lying-in hospitals, the Dublin and the London Maternity, not a single case occurred. The predisposing causes are twofold, namely, distention and relaxation of the uterine walls. The exciting or determining causes are traction on an adherent placenta, the weight of a polypus, or even forcible extraction of the child.

SYMPTOMS.—The physical sign of inversion, that which alone is to be relied on, is the presence of a globular or pyriform spongy mass, filling up the vagina or lying exterior to the vulva, according as the case is one of *incomplete* or of *complete* inversion. The hemorrhage is frequently very copious.

Inversion may be confounded with polypoid or fibrous tumors. The mistake can be avoided by attention to the following diagnostic signs. In a polypus which has passed into the vagina the tumor will be pedunculated; a probe can be passed between the pedicle and the canal of the cervix into the cavity of the uterus. The uterus can also be felt through the walls of the rectum. These peculiarities are not found in *inversion*.

In *fibrous tumors* the uterus is pervious to the sound. The outline of the womb can also be traced through the rectum, and even through the abdominal walls, and there has been a history of gradual enlargement and probably occasional hemorrhages, entirely independent of pregnancy. Several times the inverted uterus has been amputated, under the supposition that the tumor was a polypus. The danger of inversion is death from hemorrhage or from slow exhaustion in consequence of a serous hemorrhage from the lining membrane of the organ. In some instances the inversion has continued for years.

TREATMENT.—It is important that the accident be recognized early, otherwise the difficulties of reduction are enormously increased; but even chronic cases are sometimes amenable to taxis. If the placenta remains adherent, it must be detached, and the bleeding, if copious, checked by hot water. The methods of employing taxis are quite numerous, and bear the names of their authors. Thus, we have those of Tyler, Smith, Valentine, Noeggerath, Barnes, Courty, and others. In recent cases of inversion the practitioner should, after washing and oiling his hands, notice whether the os is relaxed or contracted. If the former, the mass, seized between the two hands, should be pushed directly upward, by which the pedicle will be first reinverted, followed by the body and fundus. If, on the other hand, the os is highly contracted, it will be best to indent the centre of the fundus by applying against it the tips of the fingers grouped together in the form of a cone, and force it upward until it enters the ring of the os, to be followed by the body and the neck.

In chronic cases of inversion success has followed the taxis even as long as twelve years after the accident, as in a case of Noeggerath's. When an attempt is to be made to restore an old case, the bladder and rectum must be emptied, and the patient thoroughly etherized and placed on her back, with the limbs drawn up.

In order to fix the uterus and prevent its recession, counter-pressure must be made above the pubes with one hand, or by introducing two fingers into the rectum, after Courty's plan, the uterus having been dragged down with a vulsellum, while, with the hand carried into the vagina, compression and upward pressure are applied to it.

Noeggerath succeeded in one case by indenting the body of the uterus between the thumb and finger opposite to each horn, and afterwards thrusting the horn into the canal resulting from the inversion, which was followed by the remaining portion of the organ.

A case of six years' standing, admitted into a hospital at Cincinnati, was

reduced by Dr. Tate in the following manner. One finger of the operator was passed into the rectum and applied against the surface of the os, while the finger of an assistant (Dr. Dandridge, at whose suggestion the modification was adopted) was passed through the urethra into the bladder and applied against the hard ring of the os at a point opposite to where the pressure was applied through the rectum. The neck of the uterus being thus fixed, force was exerted against the fundus with the thumbs, and a noticeable depression soon began to appear, and, further pressure being made by a candle surrounded by a rag, the reduction was finally accomplished.

Barnes succeeded in reducing an inversion by drawing down the womb and slitting the cervix at two or three points, so as to relieve the constriction, and then pushing up the fundus. The danger in this plan is that these slits may become lacerations during the efforts at reposition and extend into the pelvis.

Sir James Simpson proposed, in refractory cases of inversion, to open the abdomen and expose the seat of constriction at the os uteri in this way. Dr. Thomas, of New York, has twice carried this suggestion into effect, one of the patients dying and the other recovering. The ring of the cervix was stretched by a dilator introduced from above. The dangers of this procedure, however, are much too great to allow of its practice, except as a forlorn hope, when the operation should be done antiseptically.

Emmett has succeeded in restoring cases of inversion after other measures had failed by passing the hand into the vagina and receiving the fundus in its palm, while the finger and thumb were thrust between the mass and the cervix, thus dilating the latter, counter-pressure at the same time being made with the other hand above the pubes.

When the reduction is partial,—that is, when the fundus has been restored within the canal of the cervix,—the same author advises closing the os over the mass by means of silver sutures. If retained in this manner, there is a reasonable prospect of complete restoration occurring spontaneously. If the practitioner is foiled in his attempts at reposition by the plans described, he should resort to gentle but continuous pressure applied by means of a cup for the reception of the fundus, with a stem attached, to which an elastic strap is fastened, the ends of the latter being secured to a band carried round the body after the manner of fixing the ordinary stem pessary. The pressure must be gradually increased as the patient is able to endure it, until reduction takes place.

AMPUTATION.—Amputation of the uterus for the cure of inversion is an extreme measure, and not to be contemplated until all other methods have failed, and until the life of the patient is placed in great jeopardy by the evils resulting from the displacement. Dr. Thomas has collected 58 cases of amputation for inverted uteri, of which 18 terminated fatally.

The operation is best effected by the galvanic cautery or by the *écraseur*: the former is least liable to be followed by hemorrhage.

The uterus in amputation should be dragged down as far exterior to the vulva as possible before applying the wire of the cautery or adjusting the chain of the *écraseur*.

Dysmenorrhœa.

Operative measures not unfrequently become necessary for the cure of dysmenorrhœa. The obstructive form of the disease is caused by distortions of the neck of the uterus, such as occur in flexions and versions; also by inflammatory stricture of the canal of the cervix, or by the presence of a polypoid growth. When the difficulty is due to flexion or version, it must be overcome by the plans already described under those heads. When it arises from stricture of the canal of the neck, the narrowing must be corrected either by *dilatation* or by *incision*.

Dilatation.—In this operation the patient, previously etherized, is placed on the back across the bed, with the limbs drawn up. The operator then in-

introduces a finger into the vagina and touches the os. Along this finger as a guide is passed a dilator (Fig. 1484), the point of which is directed into the uterus, when the blades are to be forcibly separated, thus stretching the

FIG. 1484.



Dilators for the cervix uteri.

cervix. A suppository of opium, and rest in bed for twenty-four or thirty-six hours, constitute the after-treatment.

Another plan is to expose the os by expanding the vagina with a bivalve or a Sims speculum, then drawing the neck forward with a hook and steadying it while the dilator is introduced and the cervix dilated.

Incision is designed to enlarge the canal of the neck without dilatation, and is accomplished either by the hysterotome of Simpson, who devised the operation, or by scissors, as practiced by Sims.

In performing the latter operation, which may be considered the more satisfactory, the uterus is exposed by a Sims speculum, the woman being placed on her left side. A tenaculum is next sunk into the neck of the womb, with a view of fixing the organ, when the blunt-pointed blade of the uterine scissors is passed into the canal of the cervix sufficiently far to bring the point of the other blade to the insertion of the vagina, and the intermediate tissue is divided. A similar cut is made on the opposite side, thus making a bilateral section of the cervix. After sponging away the blood, a pledget of absorbent cotton soaked in glycerin is packed into the wound, and a vaginal tampon applied, which should be left in for twenty-four hours. After the lapse of three days the cotton must be extracted from the wound and replaced by another roll, prepared like the first; after this the dressing is to be renewed daily. The patient should not be permitted to leave her bed for twelve or fourteen days after the operation.

Obstruction from a polypus is to be overcome by the forcible removal of the growth.

Tumors of the Uterus.

The uterus is the seat of *benign* and *malignant* growths. Those which belong to the benign class are the *myo-fibromata* of Virchow (*fibroids* of Rokittansky), *fibro-cystic tumors*, and *polypi*. The malignant affections are *medullary cancer*, *epithelial cancer*, and *sarcomata*.

Myo-fibromata of the uterus may be either single or multiple. They are classified according to location as *intramural* or *interstitial*, when seated deeply in the walls of the uterus (Fig. 1485); *subperitoneal*, when projecting from the serous surface of the organ (Fig. 1486); and *submucous* or *intra-uterine*, when situated beneath the lining membrane of the uterus. (Fig. 1487.)

The usual location of these growths is in the body or in the fundus of the

womb. The posterior wall of the organ is most frequently affected, the anterior wall next, the lateral portions of the organ next, and the neck rarely.

FIG. 1485.



Intramural fibroma.

FIG. 1486.



Subperitoneal fibroma.

Myo-fibromata are never seen before the age of puberty, and seldom earlier than the twenty-fifth year. They are more common in the unmarried and the sterile than in child-bearing women. Negro women are singularly prone to these growths. They are often the cause of miscarriage and sterility.

PATHOLOGY.—Myo-fibromata consist of a hyperplasia or hypertrophy of the normal tissue components of the uterus. Sometimes the muscular elements preponderate (myoma), at other times the fibrous (fibroma). The former are more vascular than the latter, and consequently grow more rapidly, and are less likely to become arrested by natural processes. These neoplasms are liable to degenerations, as the *fatty*, *calcareous*, *cystic*, *carcinomatous*, *sarcomatous*, and *myxomatous*. Aneurismal dilatation of the vessels of a myoma, forming a kind of erectile tissue, is occasionally witnessed,—the telangiectasis of Virchow.

FIG. 1487.



Submucous fibroma.

CAUSES.—Although we are in possession of facts which point to some of the predisposing causes, as race, age, sterility, etc., nothing certain is known with regard to those influences which are exciting or determining.

SYMPTOMS.—The symptoms are *rational* and *physical*. Among the first may be enumerated a feeling of weight in the pelvis, menorrhagia, dysmenorrhœa, irritability of the bladder or rectum, and often pains in the back and down the limbs, owing to pressure on the sacral or crural nerves. It is not uncommon, however, for a myo-fibroma to exist without the patient's suffering from any of the symptoms which have been named, particularly when the growth is in the substance of the womb, or is growing towards the peritoneum. The *physical* signs are most conclusive, and these are ascertained by an examination conducted through the vagina, the rectum, and the abdominal walls.

In making the exploration by the vagina or the rectum, the woman is placed on her back, with the limbs drawn up and the thorax bent forward. The finger of the operator is carried up behind the cervix uteri, while the latter at the same time is forced down by strong pressure made with the other hand above the pubes, when, if any growth exists in the posterior wall, it will probably be discovered.

The examination of the anterior wall requires the finger to be thrust up in front of the cervix, while the same pressure is made over the hypogastrium. If the touch cannot be made to reach the higher portions of the organ, the latter should be drawn down by a hook or vulsellum sunk into the cervix, and the digital examination repeated. Often it will be necessary to carry the inquiry into the cavity of the womb, sounding its depths with either the probe or the finger, or with both.

If the growth is developing inward, so as to encroach on the interior of the womb, as in submucous fibromata, the projection, as well as its locality, can readily be detected with the probe. If the results of the instrumental exploration are not satisfactory, the canal of the cervix can be dilated by sponge tents and the finger introduced into the uterine cavity, and if the organ is drawn well down by the hook, or made to descend by forcible pressure applied over the hypogastrium, the entire interior of the womb, even to the summit of the fundus, can be studied by the touch. The effect of these neoplasms is to alter the form and increase the depth of the uterus, the extent of which can easily be measured by the probe.

DIAGNOSIS.—The diseases with which uterine fibroids might be confounded are *ovarian tumors*, *hæmatocele*, *cellulitis*, *retroflexion*, *anteflexion*, and *fecal accumulations*.

The following characteristics usually belong to ovarian tumors. When moved in the abdominal cavity they do not impart a corresponding motion to the uterus, as will appear by touching the os with a finger while such manipulation is practiced. This fact is proved by introducing into the uterus the uterine probe, which will remain quiet while the tumor is rolled about. The only exception to the test of uterine mobility is when the ovarian cyst is attached to the organ, when, if the tumor is a solid one, the diagnosis will be very difficult. The existence of menorrhagia, and the absence of emaciation and of fluctuation, are signs belonging to uterine fibromata and unusual in ovarian cysts. In doubtful cases the aspirator can be used to remove obscurity.

Hæmatocele differs from a fibroma in its history, coming on suddenly and being sensitive to the touch, rendering the uterus fixed, and being seldom unattended with marked constitutional disturbance. Myo-fibromata, on the contrary, are slow or gradual in their formation, do not render the womb immovable, and for some time give rise to no constitutional symptoms.

Cellulitis is accompanied by the usual signs of inflammatory fever, is sudden in its invasion, and fixes the womb, the swelling being very sensitive to the touch.

Displacements of the uterus, when the organ is retroverted, form a tumor which can be distinctly felt through the rectum, and, if it is anteverted, one which is situated behind the pubes; but to differentiate these from a myo-fibroma it is only necessary to insert the elevator of Sims or a sound into the organ, when it can readily be raised or depressed from its abnormal place.

Fecal impaction.—It is difficult to understand how a mass of hardened feces in the rectum should be taken for a fibroma of the uterus; yet such an error has been committed. The depression made on an accumulation of fecal matter by pressure exerted through the recto-vaginal septum ought to leave no doubt as to its nature.

COURSE OF MYO-FIBROMATA.—Occasionally these growths attain very large dimensions, though generally their size varies from that of a hickory-nut to that of an orange. After the menopause, when the vascularity of the uterus

is diminished, they frequently either cease to increase or become atrophied. They also become the seat of metamorphic changes which may destroy their structure, substituting for the latter collections of purulent or bloody material; and colloid degenerations have been observed. When they prove fatal, which is an unusual occurrence, the event is induced by the exhaustion incident to repeated hemorrhages and to hectic symptoms.

TREATMENT.—While engaged in teaching practical anatomy, I noticed the frequency with which fibroid tumors of the uterus were found in the dissecting-rooms; in a great many instances they had evidently ceased to grow, or had atrophied; and it is no doubt true that in a number of cases, aside from some displacement or some disturbance of the menstrual function, no inconvenience is likely to follow the presence of such growths. As long, therefore, as the tumor does not increase in size, very little interference is demanded.

It is the duty of the practitioner to correct as far as possible any displacement which may result, as the increase of the fibroma is stimulated by malposition of the uterus. During the menstrual period the woman should remain quiet in the recumbent position, thus lessening the amount of blood circulating through the organ, and in the same proportion depriving the growth of pabulum.

The remedies employed for the cure of uterine fibroids are *medicinal* and *operative*.

Medicinal treatment aims at effecting the removal of the disease by absorption. Various agents have been employed for this purpose: among these may be enumerated iodine, iodide of potassium, bromide of potassium, bichloride of mercury, chloride of calcium, muriate of ammonia, ergot, and certain mineral waters, notably those of Kreuznach in Germany.

Prominent among these remedies is ergot, administered by the mouth or hypodermically, and in sufficient quantity to maintain a gentle contraction of the uterine walls. It is intended by thus excluding a certain quantity of blood to starve the growth and arrest its augmentation, thus predisposing it to atrophy. The subcutaneous administration of the drug appears to be most efficacious, eight or ten minims of Squibb's ergotin being inserted into the cellular tissue of the abdomen every day or two for eight or ten weeks. In some instances I have seen the tumor noticeably diminished or arrested in its growth. In others, no change could be discovered. One important effect, however, will be produced by the use of ergot, viz., the diminution or entire control of hemorrhage; and this is a positive gain. The influence of hot water in lessening the circulation of a part may be utilized in the treatment of fibroids by daily using hot vaginal injections. The late Dr. Atlee attributed considerable absorbent power in these affections to the muriate of ammonia exhibited for a long time in seven- or eight-grain doses. Bromide of potassium, when the nervous system of the patient is much unsettled, will fulfill a valuable indication as a sedative. Simpson believed that this drug exercised some curative power over uterine fibroids, and gave it with this end in view.

To control hemorrhage, so often an attendant of these growths, the usual hæmostatics can be employed, as gallic acid, ergot, etc. Opium and the tincture of cannabis Indica may be given with decided benefit. Emmett has obtained capital results in cases of obstinate bleeding by dilating the canal of the cervix and injecting into the womb hot water by means of a long nozzle attached to a Davidson syringe and passed into the organ.

Electrolysis.—Apostoli, Keith, and others employ with great success electrogalvanism, from fifty to two hundred and fifty milliamperes in strength, repeated ten or twenty times, at intervals of from two to ten days, and under strict antiseptic precautions. The dispensing or cutaneous electrode is applied to a layer of potter's clay spread over tarlatan and laid upon the abdomen. The other electrode, coated with vulcanized rubber or gum shellac within a short distance of the extremity, is introduced into the uterus or

into the tumor through the lateral or posterior dome of the vagina, the positive pole always in cases of hemorrhage to be the intra-uterine one.

Operative measures are adopted sometimes for the purpose of arresting hemorrhage, as the removal of the ovaries in order to cause a premature menopause, or even hysterectomy, when the symptoms become extremely urgent. Division of the cervix, once practiced by Nelaton and by Baker Brown, has been abandoned.

Submucous myo-fibromata projecting into the cavity of the uterus are susceptible of removal, as indeed are those also which are subperitoneal and pedunculated. The first class are to be treated by *enucleation* or by *écrasement*, the latter operation being applicable only to cases in which the growth has a base narrower than its body.

Enucleation, first practiced by Amussat in 1840, though previously suggested by Velpeau, is an operation based on the fact that these growths are generally surrounded by a wall of loose connective tissue.

In removing a submucous fibroid, the neck of the uterus must be gradually well dilated by sponge tents, or rapidly by the instrument of Molins.

In effecting dilatation by tents (Fig. 1488), the neck of the uterus should be

FIG. 1488.



Sponge tent.

exposed by the speculum and steadied by fixing in it a long tenaculum or hook, while the tent, held either in the grasp of a special forceps (Fig. 1489) or by a director (Fig. 1490), is introduced into the canal of the cervix. The dilatation can usually be sufficiently accomplished by two tents; and it is desirable that, if possible, not more should be used, as the danger increases

FIG. 1489.



Tent-forceps.

FIG. 1490.



Tent-director.

with each renewal. The work will be hastened by preceding the use of the tent with the dilator, as thereby a larger sponge can be introduced. When the dilatation has been completed, a free incision is made through the capsule of the tumor and some distance into its substance with a blunt-pointed bistoury, while the uterus is drawn strongly down by a vulsellum. This done, a finger or a curette (see Fig. 1499) will often be quite sufficient to shell out the mass, when it can be extracted through the os.

Emmett, in executing an enucleation, arms the finger with a steel instru-

ment having a serrated edge. Thomas effects it by means of a spoon-saw or scoop (Fig. 1491), with which he separates the attachment of the fibroid,

FIG. 1491.



Thomas's spoon-saw.

whether it be mural or submucous. Goodell slips over the tumor a wire *écraseur*, and with this divides the capsule on a level with the wall of the uterus; after which, by seizing the growth with a *vulsellum*, and using both instruments as tractors and levers, the neoplasm is wrenched from its bed and extracted.

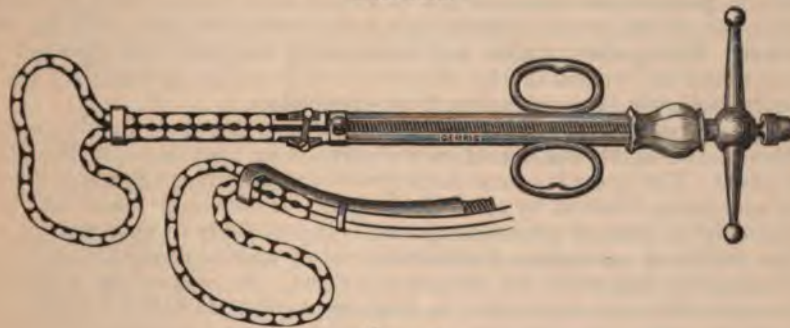
In order to gain access to intra-uterine fibroids, the neck of the womb is sometimes incised. When this plan is adopted, the operator should not attempt the extraction of the tumor until the wound in the cervix has healed.

Enucleation is not unattended with danger. The wall of the uterus may be perforated, when the tumor is deeply imbedded in its substance, or the patient may perish from peritonitis or pyæmia. Of 28 cases of this operation recorded by West, 14 proved fatal.

When enucleation is impossible, the growth may be excised piecemeal by the *tenaculum* and scissors.

Écrasement.—When the fibroid offers a base sufficiently narrow to admit of being crushed off, the chain of an *écraseur* (Fig. 1492) should be passed around the pedicle; then by turning the screw of the instrument the attachment is

FIG. 1492.



Écraseur.

gradually severed. I sometimes use piano-wire (Fig. 1493) as a substitute for the chain.

FIG. 1493.

Wire *écraseur*.

It is occasionally a difficult task to adjust the chain of the *écraseur* around the pedicle of a uterine growth: the least complex device for the purpose is a simple fork (Fig. 1494), or the *porte-chaine* of Sims will be found to answer the same purpose.

When wire is used, neither of these instruments will be required, as the loop will retain a sufficient degree of rigidity to admit of its being carried into position without any artificial aid, except perhaps that of a forked probe.

FIG. 1494.



Fork for conducting the chain of the écraseur around a fibroid.

Incision.—Fibroids have been successfully attacked by making incisions through their capsules, thus exciting sloughing, and then by the free use of ergot favoring the expulsion of the mass from the womb.

Uterine contraction constitutes an important element in the dislodgment of fibroids. Twice have I seen large tumors of this nature spontaneously expelled from the walls of the womb in this way without any preliminary incision or other operation.

Subperitoneal myo-fibromata, as a rule, admit of no operation for their removal; though if there is reason to believe that the growth is pedunculated, and the patient's condition is rapidly growing worse, she is not to be denied the benefit of an attempt to extirpate the disease. It is probable that the application

of antiseptic treatment in uterine surgery will render the operation more popular than it has heretofore been.

In order to remove a subperitoneal myo-fibroma the abdomen must be opened in the median line, as in ovarian operations. The tumor being exposed and its serous covering divided, it should, if possible, be shelled out of its bed, and, after the control of all bleeding, the wound in the parietes of the abdomen should be closed, as is done after ovariectomy. If the tumor has a narrow pedicle it can be severed by the wire écraseur, any vessels which continue to bleed being tied by the carbolized thread or sealed by the point of a cautery. In a case of an enormous fibroid, larger than a man's head, which I removed by abdominal section from a patient in the Pennsylvania Hospital, the pedicle was three inches in length and three inches in circumference, the entire growth resembling a large head of cabbage with the stalk attached. The pedicle, which was exceedingly vascular, was clamped and brought into the wound in the abdominal walls. The patient died on the third day following the operation, from exhaustion.

When, on opening the abdomen, the growth is found to involve a large portion of the womb, the operation will have to be abandoned, or the uterus extirpated. The latter is a formidable procedure, entailing a shock so tremendous, and being followed by so many dangers,—inflammatory and infectious,—that only in cases of extreme urgency is it justifiable to undertake it.

The results of operations for the removal of uterine fibromata and cysto-fibromata, as presented by different writers, are somewhat conflicting. What antiseptics may accomplish in diminishing the mortality remains to be determined; but in the light of present statistics no operator would desire, except under very peculiar circumstances, to engage in this undertaking. When such an operation is contemplated, the extirpation of the uterus along with the tumor will offer a better prospect of recovery than the attempt to remove the disease alone.

Of 119 cases collected by Polli, 77 proved fatal.

Spencer Wells,* in summing up his experience in the surgical treatment of uterine tumors by operations through the abdominal walls, gives us an analysis of 45 cases, in 24 of which the tumors were completely removed, and in 21 only exploratory incisions were made or the growth partially extirpated. Of the 24 cases, 15 died at various intervals between the third and the fourteenth day following the operation, and 9 recovered. One of these nine died six months afterwards from cancer of the remaining part of the uterus.

Schroeder's† analysis of cases of laparotomy for the removal of uterine

* British Medical Journal, July 27, 1878, p. 129.

† Ziemssen's Cyclopædia, vol. x. p. 255.

fibroids is more encouraging. His collection amounts to 108, with 78 deaths and 30 recoveries, or 27.8 per cent. In 73 of the 108 cases the uterus was removed along with the tumor, followed by 55 deaths and 18 recoveries, or 24.66 per cent. In the 35 remaining operations in which the tumor alone was extirpated, there were 23 deaths and 12 recoveries, or 34.3 per cent. Duplay's laparatomies* for the removal of fibromata aggregate 17 cases in which the tumor was removed without the uterus, with 5 cures and 12 deaths; 56 cases in which the uterus was extirpated with the fibromata, with 24 cures and 32 deaths; and 41 removals of the uterus along with cysto-fibromata, with 22 cures and 19 deaths. We have, therefore, 170 laparotomies in which both uterus and fibroid were removed, with 64 cures and 106 deaths; and 52 in which the tumor alone was removed, with 25 deaths and 15 cures.

Cysto-Fibromata.—Cystic growths of the uterus are very frequently confounded with ovarian tumors. A tumor of the uterus originally solid—for example, a myo-fibroma or a sarcoma—may undergo cystic degeneration; that is, there are formed in the neoplasm one or more cavities, which become lined with a smooth, secreting membrane. The initial excitant of the cyst is sometimes an apoplectic clot, sometimes a mucoid degeneration of the connective tissue, and at other times an inflammatory infiltration, which results in a purulent fluid.

Cysto-fibromata are not very common growths; indeed, until a comparatively recent date the disease had no place in gynecological literature. They have been particularly noticed by Cruveilhier, Lee, Spencer Wells, Atlee, Thomas, Peaslee, and Emmett.

These cysts are oftener encountered in the subserous than in the mural and submucous variety of myo-fibromata. They often grow with the same rapidity as an ovarian cyst, and acquire enormous dimensions, filling up the entire abdomen.

The diagnosis of a fibro-cystic tumor can only, as stated by Atlee, be determined by tapping. The fluid has a yellow color, is ropy in its consistency, and coagulates or becomes gelatinous after being drawn off, the coagulum having a whitish appearance.

TREATMENT.—The treatment for the most part is palliative, and consists in tapping the tumor when the cyst becomes so large as to interfere with the comfort of the patient. An operation for the removal of the disease offers very little prospect of success.

Uterine Polypi.—Polypi of the uterus covered by mucous membrane are very common growths, and present different appearances according to the preponderating element in their structures. It would be well if the term had a more restricted signification than is usually accorded to it. Three varieties of these growths may be recognized,—the *fibro-myomatous*, the *mucous*, and the *adenoid*. These growths are often essentially submucous fibroids.

Fibro-myomatous polypi.—This variety is in all respects, except in form, identical with the fibro-myomata of the uterus, commonly described as *uterine fibroids*. They consist of interlacing fibres of connective tissue, have a pale, grayish-white color, and a firm, elastic feel, are pyriform or globular in shape, and are usually attached to the interior of the body of the uterus by a pedicle, which may be long, short, slender, or thick. The weight of the growth has a tendency to increase the length, and also the tenuity, of the pedicle.

These tumors vary in size from that of a pea to that of a cocoa-nut.

Mucous polypi present a grayish, translucent appearance, have a soft, gelatinous consistency, and a long, slender pedicle, which often allows them to escape from the uterus, remaining suspended in the vagina, or even hanging out of the vulva. They are made up of scattering threads of submucous connective tissue, a few straggling vessels, and a mucoid substance which

* Reported by letter from Dr. Harris.

renders the mass tremulous and changeable under different atmospheric conditions. Its attachment is generally at the neck of the uterus. (Fig. 1495.)

FIG. 1495.



Mucous polypus attached to the cervix by a slender pedicle.

Adenoid polypi.—The adenoid or glandular polypus originates in the Nabothian glands of the cervix and cavity of the womb. These follicles become enlarged and dilated into small sacs. A group being simultaneously affected, the members of which are held together by connective tissue, and contain numerous blood-vessels, and probably muscular fibres, forms one or more pedunculated tumors of a reddish or a gray color, the size of a cherry, having a lobulated appearance, and suspended by one or several slender pedicles. These growths are covered with a smooth membrane, and contain metamorphosed mucus with the normal epithelium of the gland-tissue.

Polypi differ in vascularity, the degree of which can be determined by the color of the growth, which has a red appearance when abundantly supplied with blood. The mucous variety are generally more abundantly supplied with vessels than the fibro-mycomatous.

Other varieties have been described by writers, as the *channeled* and *tubular* polypi, distinctions founded on the presence of a hollow or canal existing in the growth. Fibrinous polypi originate, it is thought by Krenisch, from a blood-clot contracting and attaching itself to the inner surface of the uterus and becoming organized. Malignant and calcareous polypi, the former recurring tumors, the latter metamorphoses, with the salts of lime deposited in their structure, are also described by various authors.

SYMPTOMS.—Uterine polypi, in consequence of the congestion which they produce, give rise to hemorrhage, menorrhagia, and leucorrhœa. Sometimes they block the internal os or the cervix uteri, obstructing the flow of the menses, and thus becoming a cause of dysmenorrhœa.

The physical signs are alone reliable. When the growth is attached to the surface it can often be discovered, on exposure of the parts by a speculum, lying in the os or projecting into the vagina, suspended by a narrow pedicle from the cervical canal. In many instances the vagina is found filled with the growth, which, through its action as a wedge and with the aid of the uterine contractions, has gradually dilated the neck of the womb and escaped from its cavity.

If the polypus is not visible in the neck of the womb, and if there are evidences of its existence within the body of the organ, the diagnosis may be established by the probe and the finger, the latter always to be preferred. To render the digital examination practicable, the neck of the uterus must be dilated with sponge tents until the finger can be carried into its cavity, when the shape of the growth and the point of attachment can be determined.

The evils which attend the presence of a uterine polypus are anæmia and exhaustion from the loss of blood, endometritis, and sometimes displacements of the womb.

TREATMENT.—When the polypus is seen either in the cervix or in the vagina, it should be removed without delay. This can be done in several ways.

Torsion.—If the pedicle is not too thick, the tumor is most expeditiously disposed of by torsion, seizing the growth as near as possible to its attachment with a pair of strong polypus forceps (Fig. 1496) and twisting it round and round until it is detached from its connection with the cervix. In doing this the manipulation is often facilitated by sinking a hook into the neck of the womb and fixing it while torsion is made.

Écrasement.—When the pedicle is thick, strong, and fleshy, it will be divided with the greatest facility by means of either the wire or the chain

FIG. 1496.



Uterine polypus forceps.

écraseur, or by the mackerel-bill *écraseur* of the author. (Fig. 1497.) Generally there is not much difficulty in adjusting either of these instruments;

FIG. 1497.

Author's *écraseur*.

but if the contrary is the case the surgeon can resort to the contrivances employed for carrying the chain or wire described under the head of uterine fibroids.

Excision of a polypus is sometimes preferred; and when the growth is small, this operation is performed by seizing the tumor with a vulsellum and snipping the pedicle with a pair of long scissors; or it can be severed by Hodge's sickle-shaped polypotome. (Fig. 1498.) Multiple growths of this

FIG. 1498.



Hodge's polypotome.

nature which do not rise far above the surface and do not admit of torsion or crushing should be removed by scraping, or by the curette. (Fig. 1499.)

FIG. 1499.



Uterine curette.

When the polypus occupies the interior of the body or the fundus of the uterus, the difficulties of the case are greatly enhanced, especially if the tumor is broadly attached. I have seen nature come to the aid of the practitioner in so many cases of this kind, that I question very much the propriety of any operative interference so long as the health of the patient is not seriously implicated.

The uterine contractions which are provoked by these polypi tend to pedunculate the growth, so that in time a somewhat sessile base will become converted into a pedicle and the body of the tumor will be thrust into the

vagina, rendering its extraction by torsion or by *écrasement* an easy task. Indeed, the tumor may, by the above process, be completely separated from all its uterine connections and be extruded from the cavity of the womb entire. It is astonishing with what persistence some of these growths, under atmospheric pressure, cling to the vagina after leaving the uterus. In a lady whom I saw with the late Professor John Neill, a fibroid polypus which had existed for a long time had finally been delivered by the spontaneous efforts of the uterus. It was perfectly round, resembling a billiard-ball, and the size of a foetal head. It lay in the vagina, and, although entirely disengaged from all the surrounding parts, the most powerful tractions by vulsellum forceps failed to extract it. No obstetric forceps being at hand, it was finally removed by passing a lever behind the tumor and forcing it forward, while at the same time all the force at command was exerted in the way of traction.

Until a case becomes urgent, it will be best to treat it tentatively, by attending to the state of the bowels, and forbidding all violent muscular efforts or active exercise, especially during the menstrual periods, at which time the woman should be kept in bed, or at least in the recumbent position; all excess in the menstrual flow should be controlled by the use of ergot, gallic acid, opium, or aromatic sulphuric acid; any displacement which may exist should be corrected; and the effects of the exhausting menorrhagia should be counteracted by a nutritious diet and the preparations of iron, ergot, and quinia.

When operative measures cannot be longer delayed with safety to the patient, the canal of the cervix uteri must be dilated by tents to a degree which will admit the finger, thus enabling the surgeon to ascertain the position of the tumor and the nature of its attachment, when, if the polypus is pedunculated, it can be twisted off with the uterine polypus forceps, guided by the finger; or, seized by a double tenaculum (Fig. 1500), it may be drawn down and its base surrounded with the wire *écraseur* and crushed off.

FIG. 1500.



Vulsellum tenaculum.

The galvano-cautery can also be used with great advantage when the wire belonging to the battery can be safely placed around the base of the tumor. By this method the vessels are sealed and hemorrhage prevented at the same time that the parts are divided. The Byrne battery will fulfill this purpose admirably.

If the attachment of the tumor is too broad to be thus treated, the greater part may be cut away with the hook and scissors. In these last cases some advise making deep incisions into its structure, trusting to its subsequent disintegration and expulsion. This course is not without danger. The life of a patient is greatly jeopardized by the mass of decomposing material retained within the womb. In the only instance in which I adopted this plan the patient perished from pyæmia.

Ligation.—The same objection, though not with equal force, may be urged against ligation,—that is, surrounding the pedicle with a wire passed through

a double canula (Fig. 1501) and tightening the same until the base of the polypus has been cut through. Decomposition soon follows the contraction,

FIG. 1501.



Gooch's canula.

and exposes the woman to septic poison. In 59 cases treated by ligation and collected by Dr. Lee, of London, 9 died.

The hemorrhage which follows the removal of uterine polypi, if protracted, can be checked by hot water passed into the uterus, by full doses of ergot given internally, or, if very profuse, by the tampon.

Carcinoma of the Uterus.

Carcinoma of the uterus, except so far as it may be modified by structural peculiarities, does not differ from the same disease in other parts of the body. It is met with chiefly in two forms, *encephaloid* and *epithelial*. Scirrhus and colloid varieties of the disease are quite uncommon. Cancer of the uterus is very common. In 8746 cases of cancer analyzed by Simpson, 300 occurred in the uterus. Its frequency, as compared with that of other diseases incident to females, may be learned from the statement of Emmett, that of 2153 females admitted to the Woman's Hospital of the State of New York, 60, or 2.78 per cent., suffered from malignant diseases of the uterus.

The predisposing causes of cancer of the uterus are somewhat obscure. In many instances the hereditary origin of the disease cannot be doubted, but in others no antecedent history of this kind can be discovered. In 729 cases of uterine carcinoma, which embrace the collections of Lebert, Paget, and Sibley, as recorded by Thomas, only 125 could be referred to hereditary causes.

Age exerts a very marked influence on the appearance of the disease. It is never seen before puberty, or earlier than the twentieth year, the largest number of cases occurring between 36 and 46 years of age. Scanzoni, in 108 cases, found 45 of the patients between 35 and 45. According to the observation of the same writer, women who have borne several children are more commonly the subjects of uterine cancer than those who have been fruitless; and the testimony of Emmett and other gynecologists is to the same effect. The influence of regular sexual indulgence is most clearly traced in the comparative statistics of Glatter.* According to these, out of 1000 healthy Vienna women over twenty years old 459 were single, 408 married, and 133 widows; while out of 1000 Vienna women with cancer of the uterus 229 were single, 503 married, and 268 widows.

Race is believed also to exercise some predisposing influence on the disease. In evidence of this, the comparative exemption of the black race is adduced by Professor Chisolm.

Little is known with regard to the exciting causes of uterine cancer.

Encephaloid carcinoma of the uterus is frequently met with. In 34 specimens of malignant disease of this organ examined by Cornil and Ranvier, all were examples of this variety of cancer. The disease often makes considerable progress before being suspected by the patient, the only sign of any disorder of the womb being a watery or bloody discharge, and this may occur in women who, far from being broken in health, present unusual evidences of

* Ziemssen's Cyclopædia, vol. x. p. 275.

a vigorous nutrition. The disease begins in the submucous tissue of both the uterine and the vaginal surface of the os, near to or at its free border, in the form of an induration and hypertrophy. Generally one lip is first affected, and then the other. Vascular granulations soon appear after the mucous membrane has undergone ulceration, and are followed by erosion and dilatation of the outlet of the canal, giving to the os an excavated, patulous appearance. The granulations and induration extend, until the entire neck of the womb is buried in the vegetations, which bleed on being touched, and from which a blood-stained watery fluid, like the washings of raw beef, and having an offensive odor, is discharged, often soaking five or six cloths a day. On making a digital examination, the finger comes in contact with an irregular friable growth, which having once been felt will scarcely ever be forgotten. In these examinations the greatest gentleness of touch should be observed, as by rudely breaking through the granulations a large amount of blood may be lost. When the growth is exposed to the eye by the careful use of a speculum, there will be seen a red, irregular, granular, and fungous mass of vegetation.

When the infiltration attacks the neck and the body of the uterus simultaneously, it often provokes an inflammatory infiltration of the cellular tissue of the pelvis, which, pressing on the sacral nerves, occasions severe pain in one or both hips and down the backs of the thighs. This symptom is sometimes the very first complained of, and should always, when severe and persistent, and when observed in women about or after the menopause, excite suspicion of malignant disease of the womb.

Epithelioma commences on the surface of the cervix. Its course is very different in different individuals. Sometimes it is quite rapid in its progress, at other times it is slow, lasting for five or six years before threatening life. Pathologists recognize two varieties of epithelioma, the distinction consisting in the form of the cells constituting the growth, namely, the *pavement-celled* and the *cylindrical-celled epithelioma*. The particular variety of the disease will be determined by its locality. If it begins on the vaginal surface of the neck of the womb, where the normal epithelial cells are arranged in pavement-like layers, the cancer will be a *pavement-celled epithelioma*; and it is this form which is most common. If the disease begins on the mucous surface of the cavity of the cervix, where the cells are naturally cylindrical, it will be a *cylindrical-celled epithelioma*. The latter variety resembles encephaloid cancer, the vegetations being soft and moist, the disease showing a marked tendency to infiltrate the adjoining tissues, and often running its course rapidly. Examined microscopically, the diseased formation exhibits tubes and pearly bodies filled with epithelia. The anatomical appearances are also not unlike those of an encephaloid growth, viz., a soft juicy mass containing alveoli, filled with round cells, circumscribed by fibro-muscular tissue, and on which blood-vessels ramify.

In the *pavement-celled epithelioma* the granulations are small, never luxuriant, furnish little discharge, gradually excavate and destroy the cervix by erosion or ulceration, and manifest little disposition to infiltrate. This variety of epithelioma answers to the corroding ulcer of Clarke, of London. Epithelioma appears somewhat later in life than encephaloid cancer, not being common earlier than the forty-fifth, and often being seen after the sixtieth year of life.

The pain in carcinoma of the uterus is frequently severe, and possesses the quality of lancination so characteristic of malignant disease. This pain is not felt alone in the pelvis about the neck of the womb, but frequently shoots down the limbs, into the rectum, and upward towards the loins. Generally the suffering is less in encephaloid than in epithelial carcinoma. The physician will see cases where no pain, or very trifling pain, is experienced from the commencement to the termination.

Though the general health appears to be unimpaired at first, the signs of constitutional deterioration finally begin to appear. The patient loses

flesh and strength, the appetite fails, the face has a waxy or dirty, sallow appearance, and death ensues either from septicæmia or exhaustion.

DIAGNOSIS.—It is possible for carcinoma of the uterus to be confounded with papilloma and syphilitic ulceration. But an error of this kind may be avoided by considering that in the former affection there is induration of the uterine tissue, with often a free flow of a sanious or watery discharge. In syphilitic sores, the antecedent history, the other evidences of venereal origin, and the rapid improvement under specific treatment will serve to distinguish the disease.

Duration.—The duration of carcinoma of the uterus does not, as a general rule, exceed two years. I have seen exceptional instances in which the disease pursued a very chronic course, lasting for five years before the fatal issue.

TREATMENT.—When the disease is limited to the lower portion of the cervix, leaving a sufficient amount of apparently sound tissue between the growth and the insertion of the vagina, the neck should be removed without delay. This can be done by the galvano-cautery wire, by the chain, or by the wire *éraseur*.

Should the bleeding consequent on the operation be too free, it can be quickly arrested by the thermo-cautery of Paquelin, or, in the absence of anything better, by the tampon. After the amputation of the neck and the control of hemorrhage, the most suitable dressing is a pledget of absorbent cotton soaked with glycerin to which a few drops of carbolic acid have been added. Emmett advises covering the raw surface with the vaginal tissue and stitching it with sutures to the neck before applying any dressing.

When the disease has involved the entire vaginal portion of the neck, the woman must be either abandoned to her fate or the part removed after the plan of Schroeder, by seizing the cervix with a vulsellum forceps or a hook and removing all the diseased portion, with some sound uterine tissue, by a funnel-shaped incision. The above-named writer says he has performed this operation two hundred times without a death, and has succeeded in curing many cases.

When the body of the uterus has been attacked, the surgeon should be content with using palliative measures. These include both constitutional and local treatment. The first will embrace tonics, especially iron in some of its forms, quinine, arsenic, and highly nutritious food, with stimulants. The local measures are to be directed to deodorizing and disinfecting the discharges which flow into the vagina, and moderating or preventing hemorrhage. To this end nothing conduces more than carefully scraping away with a uterine curette (Fig. 1499) the rotten granulations down to the proper tissue of the neck, or to the body of the womb, when the disease occupies it, and subsequently using vaginal injections of solutions of permanganate of potash or nitrate of lead, or Monsel's solution of iron much diluted (one drachm of the salt to six ounces of water).

Extirpation of the uterus on account of cancer has been frequently performed, but, as the disease is almost sure to return, it is difficult to understand the reasons which prompt such a procedure. For results, see *Extirpation of the Uterus*.

Sarcoma, though histologically different from carcinoma, is also among the malignant affections of the uterus. The disease exhibits a singular partiality for the neck of the womb, extending gradually to the body of the organ, though occasionally the reverse is true, the body being first attacked and the morbid action spreading downward. Malignant disease of the uterus often extends to the bladder, rectum, vagina, and ovaries, giving rise to fistulæ.

It is quite uncommon, and when it does occur it is at an earlier age than is usual with cancer, and is perhaps more frequently met with among sterile than among fruitful women. The disease is frequently mistaken for fibromyomata and polypi; and, indeed, so close is the external resemblance

to the latter that often nothing short of a microscopic examination will be adequate to establish the distinction. When subjected to this test, uterine sarcomata will be found, when laid open, to present a white appearance, and to consist of a granular matrix containing spindle-form cells and nuclei. These neoplasms, when removed, are likely to reappear; hence the name *recurrent fibrous*, applied to them by Mr. Paget. As these growths increase they finally ulcerate, sending out a luxuriant crop of spawny granulations, which bleed profusely and discharge an ichorous, offensive fluid, exhausting the patient and giving rise to septicæmic infection.

TREATMENT.—Operations for the removal of sarcomatous tumors are exceedingly unsatisfactory, as it is scarcely possible to extirpate the whole of the diseased structure, even under the most favorable circumstances, and consequently its rapid reformation may be looked for. Something, however, may be gained by an operation in lessening the hemorrhage and thereby prolonging life; and when the bleeding is copious and the growth quite accessible, its extirpation is not to be declined. The constitutional measures proper in a case of this disease are tonics, a good diet, and rest in the recumbent position. Locally, benefit will be derived from vaginal washes containing tannic acid, Monsel's solution of iron, alum, nitrate of lead, bromine, or permanganate of potash.

Elongation of the Cervix Uteri.—Occasional instances of hypertrophic elongation of the neck of the uterus are seen in which this part of the organ reaches the external orifice of the vagina without any prolapse existing. In one case which was sent to me for treatment, the elongated cervix, when not turned back behind the pubes, protruded between the nymphæ, and was supposed to be a polypus. These hypertrophic elongations of the neck, when excessive, give rise to displacements of the uterus, sterility, ulceration of the os, and obstinate leucorrhœa, with other vaginal irritation.

TREATMENT.—When the hypertrophy is sufficiently great to be a source of annoyance to the patient, amputation of the neck will be proper. I have been twice compelled to perform this operation in order to give relief from the mental and physical disturbance which the elongation produced. The amputation is most conveniently and safely executed by the galvanocautery wire. When the battery is not at hand, the chain or the wire *écraseur*, especially the latter, can be advantageously substituted. It is readily applied by exposing the parts with the Sims speculum, seizing the cervix with a tenaculum and drawing it down sufficiently far to admit of a ready adjustment of the wire. In the use of the *écraseur* care must be taken not to apply the chain or the wire too near the insertion of the vagina on the cervix, as the instrument may draw in the tissues to an extent which will endanger the peritoneum by opening the cavity of the pelvis. This can be avoided either by transfixing the cervix with a stout pin above where the chain or wire encircles it, or by allowing for this tendency in the adjustment of the *écraseur* one-third as much as the length of the tissue to be removed; that is to say, in amputating one inch of the cervix the instrument should embrace, when applied, two-thirds of an inch of the neck. The stump which is left should always, after the method of Sims in amputation of the cervix, be covered by flaps taken from the tissues of the vagina, which are to be stitched around the margin of the os with silver sutures. The proper dressing is a pledget of absorbent cotton moistened with carbolated glycerin.

Extirpation of the Uterus.

The removal of the uterus may be required on account of malignant growths or of fibroid or fibro-cystic tumors, or in cases demanding the Casarean section. The operation is among the most formidable in surgery, and may be accomplished either by the abdominal section or through the vagina.

Extirpation through the abdomen.—The method adopted by Dr. Freund, of

Breslau, once popular, has, on account of its high mortality, been discarded. His plan was first the abdominal incision, then the ligature of the broad ligaments in three sections, and, after cutting the uterus away from its connection, bringing the ligatures out through the vagina with the stumps of the tubes, round ligaments, and vessels, and stitching their peritoneal edges together. (Fig. 1502.)

Two operations are practiced at present, named, according as the pedicle is kept outside of the abdomen or dropped inside, the *extra-peritoneal* and the *intra-peritoneal*.

The first, or Hegar's method, consists, after the preliminary asepsis, in a median abdominal incision sufficiently large to admit of the diseased organ's being drawn through. The uterus is then brought out, the finger carefully separating any adhesions which may exist on the posterior surface. The base near the neck is next constricted by a strong rubber cord, thus controlling its circulation.

A strong pin should now be passed through the pedicle a short distance above the cord, in order to prevent its falling back into the abdomen, after which the uterus and tumor are cut away above both cord and pin. To constrict the pedicle, Koeberle employs a wire *écraseur*, Keith uses clamps, and others resort to powerful *forci-pressure* forceps, in place of the elastic cord.

After the separation of the uterus the wound is closed, as in an ordinary laparotomy, down to the stump, the latter being crowded down to the lower angle of the wound. The parietal peritoneum, all round, is now sutured to the peritoneum of the stump immediately below the elastic cord. The end of the stump may next be cauterized, or sprinkled over with iodoform, and is then to be covered carefully by several layers of aseptic lint, over all being applied the usual antiseptic dressings.

Schroeder's method (the *intra-peritoneal*) consists, after delivering the uterus and tumor, in tying off the broad ligaments on both sides, and, after encircling the neck of the organ with the elastic cord, cutting away the uterus in a V-shaped manner, after which the sides of the stump are brought together by numerous deeply-buried sutures, the last row including the peritoneum. The stump is then dropped into the abdomen.

Extirpation of the uterus by abdominal section was first performed by Langenbeck, and in this country by Dr. Briggs, of Kentucky.

Operation through the vagina.—This operation was first carried into effect by Blundell, who performed it four times for cancer. In effecting the extirpation *per vaginam*, the neck is seized by a *vulsellum*, and dragged down low into the vagina, when the latter is dissected away from the anterior semi-circumference of the cervix, observing to keep close to the latter, in order to avoid any unusual bleeding. While the neck is still grasped and drawn down, a finger is introduced into the opening, and the peritoneum separated from the anterior part of the organ. After this, the broad ligaments, being brought into view, are to be included in ligatures. All bleeding being arrested, the fundus of the uterus is to be anteverted and drawn through the opening into

FIG. 1502.



The three divisions of the broad ligaments included in the three ligatures, showing also the opening left in the upper part of the vagina after cutting away the uterus, with the three ligatures drawn through into the vagina.

the vagina by means of a hook, when its posterior attachments are readily separated by the fingers and scissors or knife.

The results of extirpation of the uterus for fibroids, for fibro-cystic tumors, and for cancer, under the earlier methods, will appear from the following summary: * Storer† has collected 24 cases; Wood,‡ 33; Routh,§ 33; Koeberle,|| 42; Kimball,¶ 12; Demarquay,** 12; Bonnet,†† 42, and Pean,‡‡ 20: a total of 218 cases, with 81 recoveries and 137 deaths, or a mortality of 62.84 per cent. Comparing these results with those obtained by operators under modern methods, we find that under these latter there is a vast saving of human life. For example, Bigelow, of Washington, makes the mortality of hysterectomy 33 per cent., based on 573 operations, Gusserow's collection includes 359 cases, with a like mortality, and Munde's statistics make the mortality 28.23 per cent.; and there are individual operators both in this country and abroad whose death-rate does not exceed 15 per cent.,—some, indeed, whose mortality-record is as low as 10 per cent.

Vaginal hysterectomy furnishes the following results:

For fibroids, 2 cases, both married women, and both successful; for cancer, 28 cases, with 11 successes and 17 deaths. In two of the successful cases one ovary was removed with the womb. The total number is 40, with 17 deaths, 13 recoveries, and 10 in which the termination is unknown.

The prevailing causes of death after removal of the uterus are hemorrhage, shock, and peritonitis. When among those operated on for cancer the result is given as successful, it must be understood as applied to the recovery after the operation.

In view of the results obtained by electricity, after the method of Apostoli, and also of the changes which occur after the menopause, the knife, in my judgment, should be the last resort in cases of uterine fibroids.

DISEASES OF THE OVARIES.

Ovaritis.

Ovaritis, or inflammation of the ovaries, is in most instances a disease of the unmarried, induced by sexual improprieties, or by causes largely psychological, and not often seen in the married, except as a secondary result from extension of uterine disease, specific or non-specific, or from a spreading pelvic cellulitis, or peritonitis.

Schroeder recognizes two forms of ovaritis, the follicular and the interstitial. Practically these divisions are of little importance, as they cannot be recognized during life. The disease may be either acute or chronic, the former tending to terminate in the latter.

SYMPTOMS.—There are no signs distinctly characteristic of ovaritis, or at least none which are not also present in peritonitis or pelvic cellulitis. There is pain or tenderness on deep pressure over the iliac region, and especially during a bimanual examination. The menstruation is often too frequent and too free. When acute, the disease is generally ushered in with a chill followed by fever. When the left ovary is the one affected, pain is often experienced in defecation, from the pressure of the lower bowel against the sensitive organ.

TREATMENT.—Even though there is some uncertainty in diagnosing inflammation of the ovaries, the treatment is the same as that which would be proper in those affections with which it may be readily confounded,—namely,

* Dr. Baum's manuscript statistics.

† American Journal of the Medical Sciences, January, 1886, p. 110.

‡ British Medical Journal, January 4, 1873, p. 18.

§ Routh, British Medical Journal, January 3, 1874, p. 15.

|| Medical Record, 1875, vol. iv. p. 102.

¶ Medical Times and Gazette, March 11, 1865, p. 265.

** Medical Record, 1866, vol. ii. p. 36.

†† Ibid., vol. ii. p. 380.

‡‡ Gynecological Society's Transactions, vol. ix.

rest in the recumbent position, the local abstraction of blood, hot hip-baths, and hot poultices laid over the iliac and hypogastric regions, together with vaginal douches of hot water. The bowels are to be kept in a soluble condition; to allay pain, suppositories of opium should be introduced into the rectum; and to relieve restlessness, bromide of potassium, particularly at night, will be found useful.

SEQUELS.—As an acute ovaritis is likely to become chronic, the ovaries are liable to suffer from various structural alterations, as atrophy, hypertrophy, displacement, abscess, and hemorrhage.

Atrophy is both a physiological and a pathological condition, the former consequent on changes incident to the menopause, the latter the result of destructive inflammation.

Hypertrophy is caused by inflammatory infiltration into the parenchymatous structure of the organs, and may be either temporary or permanent. When the result of acute inflammation, the products of the latter are less stable in their character and undergo retrograde changes, the enlargement subsiding by resolution. But when the disease has pursued a chronic course, the infiltration becomes organized into connective tissue, which renders the hypertrophy permanent.

While it is true that in hypertrophy of the ovary the body is enlarged, it is generally at the expense of the follicular constituent, which, in consequence of the interstitial infiltration, is correspondingly diminished or atrophied.

Inflammatory attacks of the ovaries, whether acute or chronic, are inimical to fertility; and hence females suffering from ovaritis or its results are often sterile.

SYMPTOMS.—The symptoms of hypertrophy are rational and physical. The former consist of a sense of weight or dragging in the iliac region, pain or distress during defecation, and dysmenorrhœa. The physical signs are those which are obtained by conjoined abdominal and rectal pressure, by which the size of the ovary, as well as any peculiarities of form or surface, can be determined.

If these examinations are made both before and during menstruation, the enlargement will be found to increase materially when the catamenia are present.

TREATMENT.—When there is a reasonable assurance that the diagnosis is correct, rest in the recumbent position during the menstrual periods must be strictly enforced; as at that time the disease is likely to increase, from the determination of blood to the uterus and its appendages. Internally, the preparations of iodine are to be prescribed, as the tincture or the compound solution. Iodide of potassium is also recommended. Little benefit, however, is to be expected from these or from any other remedies. The hypertrophy may subside with the cessation of the menstrual function; and at all events the disease will not be likely to endanger the life of the patient. Should the structural change in the ovary, along with the physical discomfort resulting from weight, adhesion, and displacement, develop a morbid condition of mind, as hysteroidal epilepsy or menstrual mania, the question of its removal must be taken into serious consideration.

Abscess is among the most common terminations of ovaritis. The purulent accumulation fashions for itself a limiting wall or sac out of the connective tissue of the ovary; and very large collections of pus, amounting even to several pints, sometimes exist, destroying entirely the normal structure of the ovary and converting it into a large bag or sac. These abscesses exhibit a tendency to open into the bladder, examples of which have been furnished by West, Mosler, and others.

Small abscesses may remain a long time in the ovary, and, there is reason to believe, are sometimes absorbed. When the accumulation of pus is large, the sac is likely to contract attachments to the abdominal walls, to the vagina, and particularly to the rectum, and in one of these directions the con-

tents of the abscess usually find their way out of the body. Should the sac fail to become adherent, the pus is liable to be discharged into the peritoneum.

SYMPTOMS.—In addition to the other phenomena of inflammation, there are, in ovarian abscess, pain, fever, rigors, and probably a tumor bulging into the rectum or the vagina. These signs belong also to pelvic abscess: so that a doubt as to the correctness of a diagnosis must always exist in the mind of the practitioner.

TREATMENT.—Hot hip-baths, hot vaginal douches of water or chamomile tea, and flaxseed-meal poultices applied over the hypogastric and iliac regions will favor the progress of suppuration. Pain must be controlled by enemata of laudanum or by opium suppositories; and as soon as the abscess has pointed, its contents should be removed by aspiration.

Displacements.—Dislocations or displacements of the ovaries may follow from increased weight, due to inflammatory products; from preternatural relaxation of the broad ligaments; from the pressure or crowding of the gravid uterus or of a pelvic tumor; and from the contraction of bands of lymph, the result of a previous peritonitis or cellulitis. These displacements are frequently congenital. The direction of the displacement is not always the same. That into Douglas's cul-de-sac is the most common, and is sometimes accompanied by a retroversion of the uterus. Examples are recorded in which the ovary has entered one of the hernial passages: thus, in Cruveilhier's case the ovary entered the inguinal canal and descended into the corresponding labium; Kiwisch mentions a case in which the ovary occupied the foramen ovale; while Deneux, in his "*Recherches sur la Hernie de l'Ovaire*," alludes to others where these bodies followed the course of femoral and umbilical herniæ, and, in rare instances, found their way into the thyroid foramen.

An ovary which descends into Douglas's cul-de-sac may be discovered by an examination through the rectum. Not only will the body be found painful to the touch, but it may also be identified by the fact that it cannot be moved in a direction away from the side on which it belongs.

When seated in hernial regions, the tumor might be very naturally confounded with a portion of intestine or omentum. The periodical enlargement, tenderness, and pain which may be observed in the tumor during menstruation, and the dragging uneasiness experienced in the iliac and hypogastric regions, together with the form of the swelling, in which the outlines of the ovary may be distinguished, will be important diagnostic features for consideration.

TREATMENT.—If the displaced ovary is associated with retroversion of the uterus, the correction of the latter will be of the first importance, inasmuch as, if not followed by the spontaneous reduction of the dislocated ovary, it will lessen the uneasiness and pain experienced by the patient. If the ovary is found occupying the position of a hernia, and reducible, it should be replaced by taxis, and the protrusion prevented by guarding the rings with a properly-fitting truss. When its reduction is not feasible, which will most likely be the case, on account of adhesions, it will be necessary to defend the ovary against injury by a large concave pad attached to the spring of a truss. Neboux and Loeper have each operated successfully in a case of strangulated ovary by exposing the parts and dividing the obstruction by the knife. When the displacement is attended with a degree of suffering and disability, or when the tumor degenerates into an abscess or cyst, rendering surgical interference necessary, excision of the ovary will be required. The cases of Pott, Deneux, Meadows, and Lassus are in point as illustrating this plan of treatment. These gentlemen each removed successfully a displaced ovary which had become diseased. Similar operations have been done by Holmes and Guersant, but, I believe, unsuccessfully. The modern operation of ovariectomy, which is working its way into professional favor, will no doubt be frequently resorted to in such cases in the future.

Oöphorectomy, or Spaying.—Battey's Operation.

The operation of removal of the ovaries on account of extremely bad cases of dysmenorrhœa or for other morbid conditions resulting from vicious ovulation, though first performed by Professor Hegar, of Germany, on the 27th of July, 1872, and five days afterwards by Lawson Tait, must be regarded as having been formally introduced to the profession by Dr. Robert Battey, of Rome, Georgia.

There are two ways in which the ovaries may be removed, namely, through the abdomen and through the vagina. In either operation the antiseptic spray should be used and both ovaries always removed.

Abdominal spaying.—In this operation the opening through the abdominal parietes is made in the median line between the umbilicus and the pubes, but nearer to the latter, and should not exceed two and a half or three inches in length. On dividing the peritoneum a vulsellum forceps is introduced into the pelvis, preceded by two fingers, which serve to guide the instrument to the ovary; the latter is seized and drawn sufficiently into the external wound to enable the operator to pass a double carbolized silk ligature through the broad ligament below the ovary, and to tie the included tissues on each side, cutting off both ends of the threads close to the knots after the ovary has been cut away above the ligatures. One being disposed of in this way, the other ovary is to be similarly treated, and the wound in the walls of the belly closed up by silver sutures, including the peritoneum. Over the line of approximation is next laid a pledget of antiseptic gauze, which in turn is covered with carbolized cotton-wool, and the whole supported by a broad flannel bandage enveloping the body.

Sometimes, instead of using ligatures, the ovaries are crushed off close to their connection with the broad ligaments by the *écraseur*. The ligature, however, more certainly secures the patient against hemorrhage.

Vaginal spaying.—In removing the ovaries through the vagina, the woman is placed in the lithotomy position, with the hips projecting over the lower edge of the table, and an assistant on either side supporting the limbs. A Sims speculum being introduced and the posterior wall of the canal retracted, the operator seizes the os uteri with a strong hook and drags it well downward and forward, after which an opening is made through the vagina posterior to the cervix uteri, either with a sharp-pointed bistoury or with the long scissors. If the latter are employed for this purpose, the puncture can be enlarged by pushing through it the closed blades of the scissors and then separating them. This done, the surgeon introduces a finger through the opening, along which he conducts a hook, and, catching with its point the peritoneum at the bottom of Douglas's cul-de-sac, draws it through the incision in the vagina and divides it with the scissors. The cavity of the pelvis is now open, when the ovaries can be hooked down with the finger and vulsellum, pulled through the wound thus made, ligated as in the abdominal operation, and cut away.

The subsequent treatment is to be conducted precisely on the same principles as after ovariectomy.

The relative value of the two methods will depend on conditions which it is impossible to know antecedent to the performance of the operation. If the ovaries are perfectly free in the pelvis, the vaginal plan has the great advantage of making a wound in a locality which is admirably adapted for drainage; but, unfortunately, in many instances these bodies are bound to contiguous parts by inflammatory adhesions which refuse to yield, compelling the operator, as I have witnessed, to abandon the operation and adopt the abdominal section. Dr. Goodell determines the question of operation by the *mobility of the uterus*, which he deems a good index to the state of the ovaries, believing that if the former admits of being easily pulled down, the latter are less likely to be bound by adventitious bands, and therefore are probably capable of being extirpated through the vagina, while if the reverse

is true and the womb refuses to be thus manipulated, the abdominal method is to be preferred.

The harmless manner in which the peritoneum can be opened under the antiseptic spray certainly commends the abdominal as in most instances preferable to the vaginal plan of operating.

Apart from the mode of operating, however, a very important question is to be considered, namely, the propriety of the procedure itself. This must be decided by three considerations: *first*, is the operation in itself attended with very great danger to life? *second*, is the percentage of cures sufficiently great to warrant so radical a measure? and, *third*, are the evils for which it is performed sufficiently grave to justify the woman in assuming the attendant risks?

In answer to the first interrogatory I will introduce a summary of cases of Battey's operation which has been made by Dr. Paul F. Mundé in the "American Journal of Obstetrics" for 1880, the aggregate number being 120, of which number 28 died, a mortality of 22.6 per cent. The death-rate is not much above that which follows amputation of the thigh, and if the operation were done antiseptically, it would probably be very much reduced, so that, on the ground of fatality, the objections against its performance are not very forcible.

In regard to the second consideration, although these figures are sufficient to establish the propriety of this operation so far as the question of mortality is concerned, they are not sufficient to enable us to promise, even in a majority of cases, an entire return to health. Statistics are defective as regards ultimate results. We are often left uninformed whether the word *recovery* means recovery from the operation or recovery from the disease. The sufferers to whom oöphorectomy is proposed might well be pardoned if they should reply, in the words of the great master of dramatic art,—

"Rather [would we] bear those ills we have,
Than fly to others that we know not of."

That dysmenorrhœa and its common attendant, ovaralgia, are cured when the ovaries are removed cannot be questioned; but as much cannot always be said of those cases of hysteroid and maniacal insanity for which removal of the ovaries is practiced, though even in this unpromising field the operation is not barren of good results, as I have reason to know from my own observation.

The third consideration is based on the severity of the maladies for which the Battey operation is done. Is it sufficiently great to justify the risk already mentioned?

The arrival of the menopause puts an end to many of the functional disorders attending perverted ovulation, but not always to those which are organic. I think that in cases in which there are structural changes in the ovaries or the uterus constituting the exciting cause of persistent suffering and undermining the health physically and psychically, and for the relief of which all the usual remedies at command have been exhausted, there can be no good reason why the operation should not receive the unqualified sanction of the profession. The adoption of such a test will limit this procedure to a few otherwise incurable cases, and will prevent an abuse of the operation, of which there is very great danger.

The cases tabulated on the following pages, which have been collected for me from various sources by Dr. Baum, furnish some data which will be useful in estimating the proper status of oöphorectomy; though it is to be regretted that in too many of the cases the result, with regard to cure as distinct from recovery following the operation, could not be obtained.

Batley's Operation.

Operator.	Number of Cases of each Operator.	Social Condition and Age.	Indications for Operation.	Nature of Operation.	Ovaries removed.	Condition of removed Ovaries.	Result, and Source of Information.
Batley.	1	S. 30	Amenorrhœa; menstrual morbum; convulsions; repeated pelvic cellulitis.	Laparotomy.	Both.	.....	Cure complete.*
"	2	M. 32	Persistent ovarialgia (left).	Elytrotomy.	One.	Cystic degeneration.	Temporary relief; not improved.*
"	3	M. 38	Continuous ovarialgia; endometritis; threatened insanity.	"	Both.	.....	Cure complete.*
"	4	M. 24	Ovarialgia aggravated by menses or exertion.	"	One.	Not entirely removed.	Somewhat improved.*
"	5	M. 35	Ovarialgia; dysmenorrhœa; coccydynia.	"	"	.....	Temporary relief; not improved.*
"	6	M. 30	Constant ovarian pain and dysmenorrhœa; threatened insanity.	"	Both.	.....	Death.*
"	7	S. 25	Constant ovarian pain and dysmenorrhœa.	"	"	.....	Cure complete.*
"	8	M. 28	Constant ovarian pain; irritable uterus; metritis; pelvic cellulitis.	"	"	Adhesions not entirely removed.	Not improved.*
"	9	M. 35	Second operation in Case 5.	"	One.	Not entirely removed.	Not improved.*
"	10	S. 29	Constant ovarian pain; dysmenorrhœa.	"	Both.	.....	Death.*
"	11	M. 22	Atresia vaginæ.	Laparotomy.	"	.....	Cure complete.*
"	12	M. 34	Ovarian and pelvic pain; dysmenorrhœa; epileptic convulsions.	Elytrotomy.	"	Right, but not complete.	Not improved.*
"	13	M. 28	Hystero-epilepsy.	Laparotomy.	"	.....	Good. Brit. Med. Journ., April 3, 1880, p. 511.*
"	14	S. 22	Hystero-epilepsy.	Elytrotomy.	"	.....	Good. Brit. Med. Journ., April 3, 1880, p. 511.*
"	15	M. 37	Violent menstro-mania.	"	"	.....	Good. Brit. Med. Journ., April 3, 1880, p. 511.*
Shm.	1	W. 35	Dysmenorrhœa; menorrhagia; retroflexed and hypertrophied uterus.	Laparotomy.	One.	Cystic.	Cure complete.*
"	2	S. 40	Intense and ever-recurring recto-enteralgia; diarrhœa; fissure, etc.	"	"	"	Somewhat improved.*
"	3	S. 35	Dysmenorrhœa; ovarian and sacro-pelvic pain.	Elytrotomy.	"	.....	Worse.*
"	4	S. 20	Dysmenorrhœa; ovarian and sacro-pelvic pain; antelexion of uterus.	"	"	Cystic.	Worse.*
"	5	M. 38	Retroversion of uterus; ovarian and sacro-pelvic pain.	Laparotomy.	Both.	"	Death.*
"	6	S. 20	Dysmenorrhœa; coccydynia; sacro-lumbar and pelvic pain; photophobia; retroflexion of uterus.	Elytrotomy.	One.	.....	Much worse.*
"	7	M. 38	Dysmenorrhœa; ovarian and pelvic pain; hypertrophy of posterior wall of uterus, etc.	"	.....	Abandoned from being bound down by adhesions*	
Hegar.	1	.....	Ovarialgia.	Laparotomy.	Both.	One cystic, the other slightly changed.	Death.*
"	2	.....	Uterine fibroids.	"	"	.....	Greatly improved.*
"	3	.....	Uterine fibroids.	"	"	.....	Greatly improved.*
"	4	.....	Uterine fibroids (used lateral incision directly over ovaries).	"	"	.....	Greatly improved.*
"	5	.....	Uterine fibroid.	"	"	.....	* Good.*
"	6	.....	Perioöphoritis; salpingitis; perimetritis.	"	"	.....
Thomas.	1	.....	Ovarialgia; dysmenorrhœa; petit mal.	"	"	Cystic.	Somewhat improved.*
"	2	.....	Temporary insanity; dysmenorrhœa.	"	One.	Enlarged.	Death.* (Began to operate per vaginam, but was compelled to open abdomen.)
Trenholme.	1	.....	Hemorrhage from uterine fibroids; intense dysmenorrhœa from ovarian congestion.	"	Both.	.....	Cure complete.*

* From Engelmann's table, American Journal of Obstetrics, vol. xi. p. 472.

Battey's Operation.—(Continued.)

Cases.	Operator.	Number of Cases of each Operator.	Social Condition and Age.	Indications for Operation.	Nature of Operation.	Ovaries removed.	Condition of removed Ovaries.	Result, and Reference.
32	Trenholme.	2	.....	Chronic ovaritis and ovarian displacement.	Elytrotomy.	One.	.....	Not improved.
33	Peaslee.	1	.....	Absence of uterus; amenorrhoea; hystero-epilepsy; pain in coitus.	Laparotomy.	Both.	Cystic.	Death.*
34	Sabine.	1	.....	Ovarialgia; dysmenorrhoea; inability to step with left leg.	"	One.	Normal.	Greatly improved.
35	Gilmoro.	1	.....	Atrophy of uterus; amenorrhoea; cerebral congestion.	"	Both.	.....	Cured 7½.*
36	Pallen.	1	.....	Dysmenorrhoea and persistent ovariangia.	"	"	Right, cystic; left, dislocated.	Death.*
37	Engelmann.	1	M. 42	Gastric and bronchial hystero-neurosis; metritis; retroflexion of uterus; intense menstrual exacerbation.	"	"	Slightly enlarged.	Death (adhesion).
38	"	2	M. 33	Ovarialgia worse on slightest exertion; dysmenorrhoea; antelexion and epileptiform attacks.	"	"	Cystic.	Death (adhesion).
39	"	3	M. 31	Ovarialgia; ovarian dysmenorrhoea; constant pelvic pain and antelexion.	"	"	"	Death (firm adhesion).
40	Koeberle.	1	.....	Retroversion; constipation; neurosis.	"	One.	.....	Position of uterus improved.
41	Kaltenbach.	1	.....	Uterine tumor.	"	.....	.....	Death.*
42	Frew.	1	.....	Obstructive dysmenorrhoea with hysteria.	"	Both.	.....	Greatly improved. Med. Record, p. 5, 1879.
43	Prince.	1	S. 18	Hystero-epilepsy; mind wavering.	Elytrotomy.	"	.....	Death. N. E. M. vol. xi. p. 18.
44	Smith.	1	M. 40	Ovarian dysmenorrhoea.	Laparotomy.	"	Right, atrophy; left, cystic, and atrophy.	Cured. Brit. M. J. July 12, 1879.
45	Schucking.	1	M. 38	Marked hysteria; epilepsy; metrorrhagia; dysmenorrhoea and trismus.	"	"	.....	Cured. From London Record, and Med. Record, 1880, p. 284.
46	Schroeder.	1	.....	Insane girl with nymphomania.	"	"	Normal.	Cured. American Obstet., Jan. 1880.
47	"	2	.....	Large myoma.	.....	.....	.....	Improved; grew. Amer. Journ. January, 1880.
48	Langenbeck.	1	.....	Absence of vagina; menses and coitus through bladder.	Laparotomy.	Both.	.....	Cured. Amer. J. Med. Sci., January, 1880.
49	Martin.	1	.....	Violent ovariangia, with scarce menses.	.....	.....	.....	Cured completely. Journ. Obstet., 1880, p. 194.
50	"	2	.....	Violent ovariangia, with scarce menses.	.....	.....	.....	Cured completely. Journ. Obstet., 1880, p. 194.
51	"	3	.....	Uterus imperfectly developed (both ovaries on left side).	Laparotomy.	Both.	.....	Cure. Amer. J. Med. Sci., January, 1880.
52	Müller.	1	.....	Ovarian neuralgia.	.....	.....	.....	Cure. Amer. J. Med. Sci., Jan. 1880.
53	Czerny.	1	.....	Hysteria and enlarged ovaries.	.....	Both.	.....	No cure. Amer. Obstet., Jan. p. 194.
54	Lusk.	1	S. 39	Dysmenorrhoea.	Laparotomy.	"	Enlarged and cystic.	Death recorded in Journ. Obstet., 1880, p. 300.
55	Malins.	1	M. 33	Pains and irregular menses.	"	"	Normal.	Greatly improved. Med. Record, 1880, p. 77.
56	"	2	M. 36	Pain and prostration, especially at menses, also in defecation.	"	"	"	Greatly improved, desire not to menstruate by Brit. Med. Journ. 22, 1880, p. 77.
57	Freund.	1	.....	Fibro-myoma.	.....	"	.....	Death. Med. Journ., May 24, 1880; A. R. M. table.

* From Engelmann's table, Amer. Journ. of Obstet., vol. xi. p. 472.

† Private communication.

Battey's Operation.—(Continued.)

Operator.	Number of Cases of each Operator.	Social Condition and Age.	Indications for Operation.	Nature of Operation.	Ovaries removed.	Condition of removed Ovaries.	Result, and Source of Information.
Tauffer.	1	.....	Dysmenorrhœa.	Laparotomy.	Both.	.....	Cure. British Med. Jour., May 24, 1879, p. 763. A. R. Simpson's table.
A. R. Simpson.	1	M. 36	"	"	"	.....	Good. British Med. Jour., May 24, 1879, p. 763. A. R. Simpson's table.
McGuire.	1	.....	Ovaritis.	.....	"	.....	Recovered. Amer. Journ. Obstet., Jan. 1880, p. 194.*
"	2	.....	"	.....	"	.....	Recovered. Amer. Journ. Obstet., Jan. 1880, p. 194.*
Freud.	2	.....	Myomata.	Laparotomy.	"	.....	Menopause followed. Amer. Journ. Obstet., Jan. 1880, p. 194.*
"	3	.....	"	"	"	.....	Menopause followed. Amer. Journ. Obstet., Jan. 1880, p. 194.*
"	4	.....	Hystero-epilepsy.	"	"	.....	Menopause followed. Amer. Journ. Obstet., Jan. 1880, p. 194.*
Goodell.	1	S. 33	Uterine fibroids; ovaralgia; dysmenorrhœa; fear of insanity.	Elytrotomy.	"	Healthy.	Cure complete.
"	2	M.	Pernicious menstruation.	Laparotomy.	"	"	Vaginal incision failed and abandoned; abdominal resorted to; died.*
"	3	M.	Ovaralgia; pernicious menstruation.	Elytrotomy.	"	Inflamed.	Died.*
"	4	.....	Hysteroidal insanity.	"	"	.....	Recovered; improved; three years under observation.*
"		S.	"	"	"	Enlarged.	Recovered; cured; three months under observation.*
"	6	S.	Ovaralgia; threatened insanity.	Laparotomy.	"	Healthy.	Recovered; much improved; six months under notice; vaginal incision failed; abandoned, and abdominal operation resorted to.*
"	7	S.	Ovaritis; ovaralgia.	Elytrotomy.	"	Enlarged and indurated.	Recovered; much improved; five months under notice.*
"	8	S.	Ovaritis; menorrhagia.	"	"	Healthy.	Recovered; cured; three years under observation.*
"	9	S.	Ovaritis; ovaralgia.	"	"	Softened.	Died.*
Savage.	1	S. 31	Ovarian and menstrual pain; chronic metritis; enlarged and retroflexed uterus; menorrhagia.	Laparotomy.	"	Right, adherent after left; oopause followed.	rent; removed one year less pain; improved; menopause followed.†
"	2	"	"Somewhat similar to above, but no chronic metritis."	"	"	.....	Improved; life made bearable; menopause.†
"	3	S. 18	No vagina or vaginal aperture; rudimentary uterus; monthly molimen, with pelvic pain and intense pain in head.	"	"	Both cystic.	Result not stated; had never menstruated.†
"	4	M. 28	Dysmenorrhœa; dyspareunia and dysuria.	"	"	Left, shriveled; right, normal size; calcareous pieces removed.	Adhesions; improved; not so much pain; not complete removal of right ovary.†
Tait.	1	.....	Hemorrhage from myoma.	"	"	.....	Death. British Med. Jour., May 3, 1879, p. 813.
"	2	.....	" " "	"	"	.....	Death. British Med. Jour., May 3, 1879, p. 813.
"	3	.....	" " "	"	"	.....	Death. British Med. Jour., May 3, 1879, p. 813.
"	4	S. 26	Dysmenorrhœa.	"	"	.....	Under observation one year; complete relief. British Med. Jour., July 10, 1880, p. 48.
"	5	"	"	"	"	.....	Under observation six months; complete relief. Brit. Med. Jour., July 10, 1880, p. 48.

* Private communication.

† Obstetrical Journal of Great Britain and Ireland, May 31, 1880, p. 258.

Battey's Operation.—(Continued.)

Cases.	Operator.	Number of Cases of each Operator.	Sex and Age.	Indications for Operation.	Nature of Operation.	Ovaries removed.	Condition of removed Ovaries.	Result, and Date of Discharge.
83	Tait.	6	S. 34	Dysmenorrhoea.	Laparotomy.	Both.	.....	Under observ- tion; great improvement in Brit. Med. J. 10, 1880, p. 4
84	"	7	M. 43	Menstrual epilepsy and mania.	"	"	.....	Complete cure and mental improvement; menstruation normal. Brit. Med. J. 10, 1880, p. 9
85	"	8	S. 28	Dysmenorrhoea.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 9
86	"	9	S. 24	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
87	"	10	S. 21	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
88	"	11	M. 29	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
89	"	12	M. 22	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
90	"	13	M. 34	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
91	"	14	M. 37	"	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
92	"	15	S. 17	Menstrual epilepsy and mania.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
93	"	16	M. 23	Dysmenorrhoea.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
94	"	17	S. 21	Menorrhagia. Cause un- known.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
95	"	18	W. 47	Hemorrhage from myoma.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
96	"	19	W. 52	" " "	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
97	"	20	M. 34	" " "	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
98	"	21	S. 48	" " "	"	"	.....	No hemor- rhage; great improvement. Brit. Med. J. 10, 1880, p. 4
99	"	22	S. 36	Menorrhagia from hyper- trophied ovaries.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4
100	"	23	S. 52	Hemorrhage from myoma.	"	"	.....	Under observ- tion; great improvement. Brit. Med. J. 10, 1880, p. 4

Batley's Operation.—(Continued.)

Cases.	Operator.	Number of Cases of each Operator.	Sex and Age.	Indications for Operation.	Nature of Operation.	Ovaries removed.	Condition of removed Ovaries.	Result, and Source of Information.
101	Tait.	24	S. 42	Hemorrhage from myoma.	Laparotomy.	Both.	.....	Under observation two months; complete arrest. Brit. Med. Journ., July 10, 1880, p. 48.
102	"	25	M. 33	" " "	"	"	.....	Under observation two months; complete arrest. Brit. Med. Journ., July 10, 1880, p. 48.
103	"	26	S. 38	" " "	"	"	.....	Death. Brit. Med. Journ., July 10, 1880, p. 48.
104	"	27	S. 46	" " "	"	"	.....	Under observation two months; complete arrest. Brit. Med. Journ., July 10, 1880, p. 48.
105	"	28	M. 39	" " "	"	"	.....	Under observation two months; complete arrest. Brit. Med. Journ., July 10, 1880, p. 48.
106	"	29	M. 38	Abscess of ovary.	"	"	.....	Complete arrest. Brit. Med. Journ., July 10, 1880, p. 48.
107	"	30	M. 46	Hemorrhage from myoma.	"	One, and other partly	.....	Death. Brit. Med. Journ., July 10, 1880, p. 48.

Of 107 cases in which the indications for operating have been stated, after deducting 10 cases where only one ovary was extirpated, one of which died, 6 cases of uncompleted operation, all recovering, 2 cases in which the result is not stated, and 1 accidental removal, there remain 88 cases of completed double operation, of which 67 recovered and 21 died, or 23.86 per cent.

General Summary of all Cases of Oöphorectomy, or Batley's Operation, included in the Preceding Table.

Operator.	Total Cases.	Laparotomy.		Elytrotomy.		References.
		Recovered.	Died.	Recovered.	Died.	
Hegar.....	42	35	7	.....	.....	Hegar's table, Lon. Med. Record, March 15, 1880, p. 85.
Schroeder.....	2	2	.....	.....	.....	" " " " " "
Freud.....	4	3	1	.....	.....	" " " " " "
Langenbeck.....	1	1	.....	.....	.....	" " " " " "
Martin.....	3	3	.....	.....	.....	" " " " " "
Müller.....	3	3	.....	.....	.....	" " " " " "
Czerny.....	3	2	1	.....	.....	" " " " " "
Schucking.....	1	1	.....	.....	.....	" " " " " "
Batley.....	15	3	.....	10	2	12 cases, Trans. Amer. Gyn. Soc., vol. i. 3 cases, Brit. Med. Journ., April 3, 1880, p. 511.
Trenholme.....	2	1	.....	1	.....	Hegar's table.
Goodell.....	9	1	1	5	2	Personal communication.
Sims.....	10	5	1	4	.....	Hegar's table.
Engelmann.....	3	.....	3	.....	.....	" "
Thomas.....	2	1	1	.....	.....	" "
Peaslee.....	1	.....	1	.....	.....	" "
Sabine.....	1	1	.....	.....	.....	" "
Von Nussbaum.....	1	1	.....	.....	.....	" "
Tauscher.....	1	1	.....	.....	.....	" "
Netzel.....	1	.....	1	.....	.....	" "
Pernice.....	2	2	.....	.....	.....	" "
Alberts.....	1	.....	.....	1	.....	" "
T. Spencer Wells.....	1	1	.....	.....	.....	" "
A. R. Simpson.....	1	1	.....	.....	.....	" "
Kaltenbach.....	1	.....	1	.....	.....	" "
Gilmore.....	1	1	.....	.....	.....	" "
Martin.....	2	2	.....	.....	.....	" "
Fallen.....	1	.....	1	.....	.....	" "
Koeberle.....	1	1	.....	.....	.....	" "
Frew.....	1	1	.....	.....	.....	" "
Prince.....	1	.....	.....	1	.....	" "
Wolponer.....	1	1	.....	.....	.....	" "
Esmarch.....	1	1	.....	.....	.....	" "

General Summary.—(Continued.)

Operator.	Total Cases.	Laparotomy.		Elytrotomy.		References.
		Recovered.	Died.	Recovered.	Died.	
Tait.....	30	25	5	.....	.....	Brit. Med. Journ., May 31, 1879, p. 813, 3 cases. Brit. Med. Journ., July 10, 1880, p. 48, 27 cases
West.....	1	.....	.....	1	.....	Hegar's table.
Noeggerath.....	10	8	2	.....	.....	" "
McGuire.....	2	2	.....	.....	.....	" "
Malins.....	2	2	.....	.....	.....	Brit. Med. Journ., May 22, 1880, p. 772.
Heywood Smith.....	1	1	.....	.....	.....	" " July 12, 1879, p. 41.
Lusk.....	1	.....	1	.....	.....	Amer. Journ. Obstet., July, 1880, p. 599.
Savage.....	4	4	.....	.....	.....	Obstet. Journ. Great Britain and Ireland, May 31, 1880, p. 238.
Total.....	171	117	27	22	5	

Formulating the material of the above table, there were 171 cases, of which 139 recovered and 32 died, or 18.72 per cent.

Of the 171 cases, there were 144 by laparotomy, of which 117 recovered and 27 died, or 18.75 per cent.; and 27 by elytrotomy, with 22 recoveries and 5 deaths, or 18.51 per cent.

Up to September, 1879, Hegar* had performed 42 operations, all by laparotomy. Of these 35 recovered and 7 died, or 16.64 per cent. He has arranged these cases into groups.

The first group consisted of 13 cases, with distinct, small tumors, either bilateral or unilateral. Here it is difficult to draw the dividing-line between ordinary ovariectomy and oöphorectomy. Both ovaries were removed in all the cases, and the tumors were about the size of a billiard-ball. The affections were exceedingly diverse, as ordinary follicular or papillary cystomata, dermoid, parovarian, and so-called tubo-ovarian cysts, etc. Extensive peritonitis and adhesions were present. Death occurred in 2 cases; all symptoms disappeared in 8, and 3 had subsequent abdominal pains.

The second group, of 12 cases, comprises fibroids. The tumors were not very large. The operation is of doubtful propriety when large fibroids are present. Death occurred in 3 cases from septic peritonitis. In 6 cases complete menopause and shrinking of the tumor occurred; in 2 cases, of three or four months' standing, menopause continued; 1 case, with large tumor, was relieved. The tumor, however, recurred, followed by hemorrhage, and death in eleven months.

The third group embraced 5 cases of chronic oöphoritis. One died, and 3 were relieved from all trouble, even after extended observation.

The fourth group was made up of 5 cases, chiefly of uterine affections, such as incorrigible retroflexions, sharp antelexions, and hyperplasia. Death followed in 1 case from ileus; menopause, with relief, occurred in 2; and 2 were too recent to form a prognosis.

The fifth group contained 7 cases, with decided chronic inflammation of recurrent character, perioöphoritis, salpingitis, perimetritis, and parametritis, with adhesions, and neuroses, culminating in insupportable suffering. None fatal. In 3 menopause and complete cure followed; in 1 menopause, and much improvement; in 1 regular typical hemorrhage accompanying improvement. Two cases were too recent to justify any prognosis.

Results.—After deducting fatal and too recent cases, there remain 28, of which number 21 are perfect results; in 1 there was transient success; in 3 pains continued after extirpating small ovarian tumors; and in 3 there was considerable improvement.

Influence upon menstruation.—After deducting the fatal cases, those which were too recent, and those in regard to which no information was received,

* American Journal of Obstetrics, January, 1880, p. 194.

there remain 30 cases. Of these, the menopause was complete in 26; in 3 there were irregular hemorrhages; and in 1 there was typical hemorrhage.

"Of 132 cases of extirpation of both ovaries during menstrual life, there were 15 which had, so far as I can learn, regular monthly fluxes, and 9 in which such fluxes were either irregular or lessened in amount."*

He thinks that all such cases have been deemed worthy of note, and that not all cases of double ovariectomy have been published. Koeberle asserts that the menstrual flux never returns unless a portion of the ovarian stroma has been left behind, and that this may occur whenever the pedicle is short and the clamp is used. All his cases had "amenorrhœa."

Tumors of the Ovaries. Cystomata.

Tumors of the ovaries may be classified as *benign* and *malignant*. They are also divided into *liquid*, *solid*, and *mixed*.

Liquid or *cystic* tumors are parasitic, follicular, parenchymatous, or retrogressive or liquefying.

Parasitic cysts are such as are formed around a species of the echinococcus, and are so rare that our information on the subject is very imperfect.

Follicular cysts are often described as dropsy of the Graafian follicles. They are sometimes single, affecting a single follicle, and at other times numerous, implicating a large portion of the follicles of the ovary.

These cysts are probably developed from an increase of the normal fluid contents of the follicle, the latter, from some cause, refusing to rupture. They answer to the so-called *retention cysts*; or, after the rupture of a follicle the opening may, according to Rokitansky, again close, and a cyst be formed between the wall of the Graafian body and the corpus luteum. Interstitial cysts also form in the connective tissue of the ovary independent of the Graafian follicles, and having for a wall the tunica albuginea of the ovary.

Waldeyer regards all cystic tumors as epithelial, or originating in the glandular component of the ovary, and possessing in themselves the characteristics of both mucous membrane and skin. As it is not contemplated to enter into any detailed description of the different views entertained by writers with regard to the pathology of ovarian tumors, I shall simply adopt that division of the subject which is commonly recognized, and which answers for the practical end in view.

Varieties.—Ovarian cysts appear as simple and compound tumors, or *unilocular* and *multilocular*.

Unilocular.—The simple unilocular or monocystic cyst consists of a single sac formed of the tunica albuginea of the ovary. The unilocular tumor is thought by some to be multilocular in its early stage of formation, the walls in that stage either melting down by absorption or disappearing by rupture. The cyst-wall differs in thickness in different tumors, being sometimes quite thin, but oftener thick from interstitial additions to its structure.

Compound or *multilocular* cysts are those from the walls of which other cysts arise, developed from the inner surface of the first (endogenous), or as outgrowths from the original wall (exogenous), or, finally, as the simultaneous development of a number of cysts, each formed from a Graafian follicle. (Figs. 1503, 1504.) In the compound or multilocular variety the different cysts may communicate with one another by the breaking down, absorption, or rupture of their contiguous walls, or they may remain as independent and distinct compartments. (Fig. 1505.)

Contents.—The contents of ovarian cysts differ in color, in consistence, and in quantity. The color may be brown, resembling that of soft soap, dark yellow, or, when the cyst contains blood, reddish brown.

In consistence the contained material is sometimes thin, sometimes ropy, and frequently gelatinous, and so dense that it refuses to escape, even through

* Goodell's Lessons in Gynecology, 1879, p. 285.

the largest canula. In addition to the liquid contents, ovarian cysts often contain myxomatous, papillomatous, hydatid, and adenoid formations. Those

FIG. 1504.



Interior of a multilocular cyst: AA, lining membrane; BBB, groups of secondary cysts; CCC, secondary cysts the walls of which have given way and are being absorbed.

FIG. 1503.



Endogenous multilocular cyst containing secondary and tertiary cysts.

belonging to the dermoid class may contain foetal remains, as bone, cartilage, hair, teeth, etc. When a papilloma exists, formed by a proliferation of the connective tissue of the tumor, blood is often found in the sac, derived from the frail vessels of the growths, which have given way.

FIG. 1505.



Multilocular cyst, loculi distinct.

Multilocular cysts, as a rule, are more likely to be filled with thick contents than the unilocular ones.

These growths attain in many instances enormous dimensions, and contain not unfrequently from six to eight gallons of fluid. If the theory is correct that these cysts are developed from the glandular parenchyma of the ovary, their contents must be largely derived from a degeneration or liquefaction of the cells within.

The ovaries are not equally liable to cystic disease, the right being more frequently attacked than the left. In an aggregate of 680 cases, 346 were on the right and 252 on the left side. Both ovaries may be affected at the same time, the pro-

portion of double tumors being about 6 per cent.

CAUSES.—Among the causes which have been thought to explain the development of ovarian tumors, *age* is the most notable. In an analysis of 1123 cases of ovariectomy, the largest number in any decade between fifteen and seventy—315—occurred between the ages of twenty-five and thirty-five. The period of life at which the function of ovulation is most active is that

between twenty-five and forty-five. Examples of the disease, however, are sometimes witnessed both in infancy and in old age. Married women are more frequently the subjects of ovarian dropsy than women who are single. In 1123 ovariectomies collected from various sources, 679 of the patients were married and 444 single.

SYMPTOMS.—The general signs of an ovarian tumor are enlargement of the abdomen, a dragging weight in one or other of the iliac regions, perhaps vesical or rectal irritation, and gradual loss of flesh. As these symptoms are common to other abdominal tumors, they are valueless when considered by themselves.

DIAGNOSIS.—The recognition of an ovarian tumor must be effected by a physical examination.

To conduct this properly, the woman should be placed on her back, the abdomen uncovered, and, that the parietes of the latter shall be sufficiently relaxed, the knees must be drawn up. Deep pressure being made in the iliac and hypogastric regions, it will not be difficult to detect a tumor if one exists. But there are many tumors other than ovarian which occur within the compass of these regions, and with which the variety under consideration may be confounded, among which may be named the fibro-cysts and the fibro-myomata of the uterus, cysts of the broad ligament, ascites, pregnancy, renal cysts, phantom swellings, carcinoma, fecal accumulations, etc. I shall confine myself to a few salient diagnostic characteristics.

If the tumor has not risen from the pelvis and there have been symptoms attracting the attention of the patient, a bimanual examination should be made, with the object of determining the origin of the growth, *whether uterine or ovarian*. With the body and limbs flexed, and by means of simultaneous pressure made through the vagina and over the hypogastrium, it is possible to ascertain whether the tumor is central or lateral, and, if the latter, even to feel the notch or interspace between the uterus and the ovary.

By the same manipulation the independent mobility of the two may be established if the disease is ovarian. Again, if a sound is introduced into the uterus and it remains motionless while the tumor in question is pressed from side to side, there is an additional reason for believing it to be ovarian and distinct from the womb.

In the case of pedunculated subperitoneal fibromata, the differentiation would necessarily be more difficult, as the tumor, especially when the pedicle is long, could be carried to one side without disturbing the stability of the uterus. In cases of this kind, unless the disease is cystic, the enlargement would feel much more dense than is common in ovarian cysts.

Again, uterine fibroids are often multiple, and if, on examination through the rectum, vagina, or abdominal parietes, other nodules could be discovered, they would be confirmatory of the uterine origin of the disease.

Fibro-cystic growths of the uterus and of its appendages present many symptoms in common with ovarian tumors. But there is one notable difference, which has been properly insisted upon by Atlee, namely, the spontaneous *coagulation* of the fluid drawn from the former when exposed to the air. This does not occur in that derived from an ovarian cyst. The microscopic appearances of the fluid of fibro-cystic tumors are also claimed to be significant: it is said to contain a few spindle-shaped or fibre cells in addition to large epithelial ones. (Fig. 1506.) This fibre cell is said to belong to no other abdominal dropsical fluid.

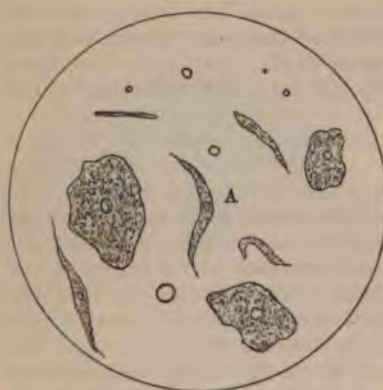
Uterine tumors are more generally attended by disturbances of the menstrual function than are those connected with the ovaries. In the former menorrhagia is quite common; not so in the latter. In the former, also, we frequently find the cavity of the uterus increased in depth, but not so in ovarian disease. Emaciation is a characteristic of ovarian, but not of uterine growths.

Even when it has been settled that the tumor is in the ovarian region, there still remains the doubt whether it may not be seated in the broad ligament,

and not in the ovary,—a cyst, for example, similar to that represented in Fig. 1507.

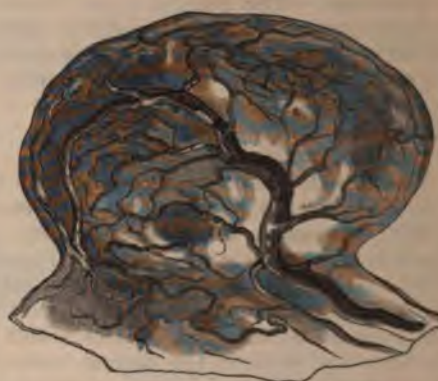
The late Dr. Atlee pointed out in this connection a very important diag-

FIG. 1506.



Fibre or spindle cells, also epithelial cells, found in fibro-cystic tumors of the uterus.

FIG. 1507.



Cyst of the broad ligament mistaken for an ovarian tumor.

nostic sign, viz., that the fluid which is contained in the cyst of a broad ligament differs widely from that of an ovarian sac. It is thin, clear, colorless as water, and of a specific gravity not exceeding 1009; it is not coagulated by either heat or nitric acid. Chemically it is rich in chloride of sodium. These characteristics are foreign to ovarian fluids, which are opaque, viscid, and rich in fibrin.

When the ovarian cyst rises from the pelvis into the abdomen, the question of ascites and pregnancy will naturally come up in the consideration of the case.

Between *ascites* and ovarian dropsy there are certain differences not difficult to detect. In ascites the fluid is diffused, the dullness on percussion general, and the distention of the abdominal walls quite uniform in all directions; while in ovarian dropsy the fluid is more circumscribed, the percussion sounds being resonant or clear in certain regions exterior to the sac, as the iliac and lumbar, when the patient is placed on one or the other side. Neither do the flanks bulge as in ascites. An examination in ascites generally reveals some cardiac, hepatic, or renal disease, which is not usual in cases of ovarian tumor. Again, in ascites the fluid is thin and straw-colored. In ovarian disease it is thick, syrup-like, or gelatinous, and generally very much darker in color.

Both ascites and ovarian cysts are often found in the same patient; but even then the walls of the latter may be discovered by palpation.

From *colloid*, *encephaloid*, and *papillomatous tumors* it is often impossible to distinguish ovarian cysts, especially of the multilocular variety, without making an exploratory opening. Generally in the former affections there is more local suffering or pain, with greater implication of the general health, and the marks of a cachexia are more strongly impressed on the face than in ovarian disease.

Ovarian cysts may have outgrowths of connective tissue highly vascular, projecting into the interior of the sac or situated upon its peritoneal surface, thus blending with the ovarian a papillary element. When the contents of an ovarian tumor exhibit the presence of much blood, the existence of such a growth may be strongly suspected.

In forming a diagnosis, therefore, in cases of abdominal tumors containing fluids, tapping should not be neglected.

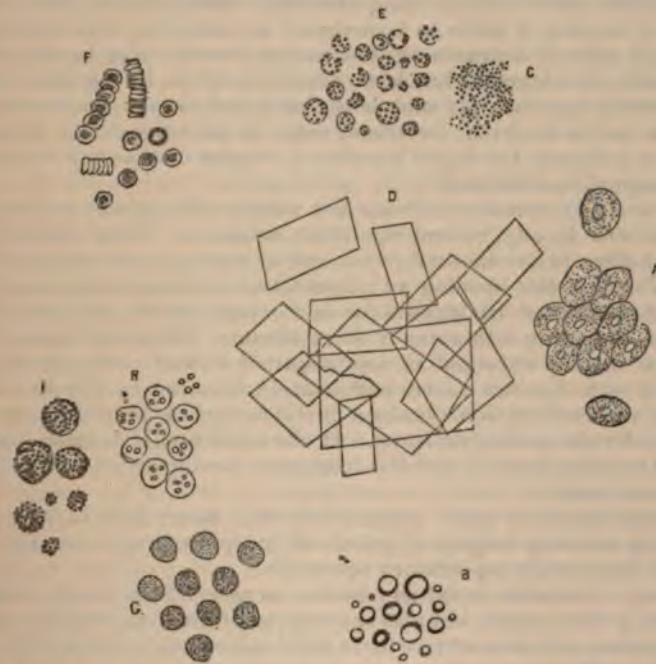
It would seem impossible to confound the *gravid uterus* with an ovarian

tumor, but the mistake has been made. The suspension of the catamenia, the continuity of the cervix uteri with the abdominal enlargement, the two moving together, the enlargement of the mammae, and the sounds of the foetal heart, which distinguish pregnancy, ought to be sufficient to prevent such an error from being committed.

Hydronephrosis and *renal cysts* in many instances give rise to such alterations in the urine as will aid in differentiating enlargements. (See *Hydronephrosis*.)

Diagnostic tapping.—Dr. Drysdale, of Philadelphia, who has examined a large number of abdominal fluids, asserts positively the existence of a distinct specific ovarian cell, which he says can always be recognized. This statement, if correct, must be regarded as of the utmost importance in imparting certainty to the diagnosis. This cell is described as an albuminoid body, oval in form, and having a granular appearance under the microscope, without a nucleus, and usually about the size of a pus-corpuscle. As granular cells are present in other abdominal fluids besides those contained in ovarian tumors, Dr. Drysdale relies on acetic acid and ether as differentiating tests. When the first agent is added to the fluid within the field of observation, the cell, if ovarian, will remain almost entirely unchanged, the granules possibly becoming a trifle more distinct, but no nuclei appearing as in pus cells; while the addition of ether causes the granules to become somewhat more transparent. Fig. 1508, taken from Dr. Drysdale's pamphlet on the subject, exhibits a number of microscopic forms usually present in ovarian fluids.

FIG. 1508.



A, Epithelial cells of different forms; B, oil-globules; C, granular matter; D, crystals of cholesterol; E, ovarian cell; F, blood-corpuscles; G, pus-corpuscles; H, pus-corpuscles treated by acetic acid; I, exudation-corpuscles in leucocytes.

Many very competent microscopists, however, deny the existence of any distinctive ovarian cell; so that the subject may be regarded as still *sub judice*. Excluding altogether from the examination the cell in question, it is quite evident that the inspection of the contents of ovarian tumors is calculated

to facilitate a diagnosis. The plan of abstracting such contents may be properly considered in this connection. This can be accomplished by aspiration, by the abdominal trocar, by puncture, by the exploring needle, and by the hypodermic syringe. Simple as are these operations, they are not unattended with danger. Kiwisch, in an analysis of 130 tapplings, reports a mortality of 17 per cent. The deaths are to be attributed to peritonitis, developed by the contact of some portion of the fluid contents of the tumor with the surface of the peritoneum, or to purulent infection, probably occasioned by the admission of air into the interior of the sac. Death has also happened from the trocar wounding a large vein distended over the sac, or, as in the case related by Scanzoni, situated in the omentum which covered the cyst.

Of the different methods named, two should take precedence of all others, namely, the hypodermic syringe, or preferably the aspirator, unless the contents are gelatinous or semi-solid, when a large trocar can be substituted. A sufficient amount of fluid can be obtained for the purpose of examination by either of these instruments. In using the hypodermic syringe, after plunging the needle into the tumor at a point where the fluctuation is most evident, the piston of the instrument should be withdrawn, in order to suck out a portion of the liquid, which is often too tenacious and thick to run without aspiration. When the aspirator is employed, it is best to use a small trocar, and after drawing off the fluid to cover the puncture with a strip of adhesive plaster, and enjoin rest in the recumbent position in bed for three or four days, administering, if necessary, an opiate.

The existence of a large accumulation of ascitic fluid may constitute a source of error if the tapping is carelessly done. This fluid is so unlike that furnished by an ovarian cyst, being thin and straw-colored, that its appearance during tapping is liable to be accepted as indicating no ovarian growth. Accordingly, after it is drawn off, the canula should never be removed until, by the touch, the abdomen has been explored, when it has often happened that a tumor is detected. If such is the case, and on percussion or palpation fluctuation can be detected, the trocar must be introduced and the sac punctured, when probably the liquid peculiar to ovarian disease will be discharged, and the diagnosis established.

Incision.—An exploratory incision as a means of diagnosis is often a necessary antecedent to any radical operative measures. This should be made in the linea alba, below the umbilicus, and at first not exceeding one inch in length. Through this opening an examination of the growth may be made, and a steel sound can be introduced and swept round the exterior of the tumor, thus detecting adhesions if there are any. If more light is desired, the incision can be enlarged to any required extent. Of course all such exploratory openings are to be immediately followed by the formal operation when the information obtained justifies such a procedure, and are to be made under the antiseptic spray. If the operation is deemed inadvisable, the wound must be dressed, and the treatment conducted in the same manner as after ovariectomy.

An ovarian tumor in some instances is of a more solid variety than the cystic, being made up largely of glandular neoplasms, and can therefore be recognized only by an exploratory operation.

It is always desirable, as far as possible, to ascertain not only whether the tumor is or is not ovarian, but also the variety of the cyst, whether unilocular or multilocular; whether or not there exist adhesions, and whether the pedicle is long, short, or twisted.

(1) When the tumor is of uniform surface, has had rapid growth, and the fluctuation is felt distinctly on the side opposite to where the palpation is applied, the presumption is in favor of a unilocular sac.

Multilocular cysts, when exogenous, are somewhat irregular on the surface, and are less fluctuating, on account of the contents being generally consistent or gelatinous. Tapping will furnish valuable evidence as to the form of the cyst. When the cyst is unilocular, the fluid is usually of a straw or brown

color, and of medium consistence. The tumor diminishes equally and uniformly on all sides, as its contents are completely discharged through a single puncture.

When the tumor is multilocular, its contents are thick and gelatinous, and before all can be removed it is necessary to direct the point of the trocar in different directions in order to puncture other cysts. The tumor, also, as it is emptied, diminishes or collapses unequally.

(2) With reference to adhesions and their extent, it is impossible to pass beyond the region of conjecture antecedent to opening the abdomen; but there are some points worthy of attention.

First, unilocular cysts are less likely to contract attachments to surrounding parts than are multilocular. Secondly, a history characterized by the absence of abdominal tenderness or pain would be favorable to the non-existence of adhesions. Thirdly, freedom of movement, the tumor rolling from side to side as the patient changes her position, or settling into the pelvis without any sensation of dragging when the erect position is assumed, makes it probable that there are no inflammatory attachments.

On the other hand, when the tumor has grown slowly, is multilocular, has been at different times accompanied with severe local tenderness and pain; when the walls of the abdomen cannot be readily slid over the tumor; or when, on placing the hand or the ear upon the parietes over different portions of the cyst, the patient breathing fully and rapidly, a friction or creaking sound is felt or heard, adhesions are certainly present. Much may be learned also by digital examination through the vagina. If, on making this while the pelvis is elevated, no recession of the uterus or of the dome of the vagina is detected, it is probably due to the tumor being tied down in the pelvis by inflammatory bands.

There is no organ in the abdomen nor any portion of the parietes to which these ovarian tumors are not liable to become attached; and, while all such adhesions increase the difficulties and dangers of an operation, they are neither insuperable obstacles to the removal of the disease nor necessarily fatal to the success of the case.

(3) An operator, when contemplating the extirpation of an ovarian cyst, considers, among other things, the pedicle of the tumor. When the cyst, with the lower part of the abdomen, projects well forward, overlapping the thighs, showing that the tumor rises above the brim of the pelvis, or when the tumor is not distinguishable through the walls of the vagina, and the os uteri is higher than normal and the womb fully movable, we have a combination of signs which signify a *lengthy pedicle*.

If, on the other hand, the middle portion of the abdominal parietes as compared with the lateral is only moderately prominent, or if the uterus is low in the pelvis and abnormally fixed, or the tumor itself can be felt encroaching on the walls of the vagina, the existence of a *short pedicle* may be inferred.

The mobility of an ovarian cyst, by permitting the tumor to revolve on its axis, exposes the pedicle to strangulation or twist, and such a condition may be conjectured when the patient is seized with severe uterine contractions, or spasms of pain, situated in the region of one of the ovaries, and aggravated by changes in the position of the body, as when the patient turns on the side opposite to the one occupied by the pedicle.

Duration of the disease.—The progress of ovarian dropsy, when left to itself, differs in different subjects. The drift of the disease is always to a fatal termination, and this, in a majority of instances, occurs within three or four years, produced by peritonitis, exhaustion, or organic disease induced by mechanical pressure. Spontaneous cures are exceedingly rare. A lady at one time under my care preparatory to the removal of an ovarian tumor suddenly began to pass a large amount of what she supposed was urine. As this went on, the abdominal swelling diminished and finally entirely disappeared. It was evident that the sac had contracted an adhesion to the bladder, and a communication between the two had taken place by ulceration,

thus opening a convenient route for the escape of the fluid. The lady returned home, and had no return of the disease for over a year, when the same accumulation reformed, and again I was consulted with reference to an operation. Acting on the previous history of the case, I advised delay, and a second time the sac was emptied in the same way, since which time, now three years, no accumulation has taken place.

In some instances ovarian tumors open into the colon or the rectum, or they may rupture and pour their contents into the abdomen. They have also been known to empty themselves through the walls of the belly.

Circumstances promising a successful result.—In regard to the chances of recovery after an operation for the removal of an ovarian cyst, the prognosis will be highly favorable if the general condition of the woman is reasonably good; if the tumor is unilocular; if there are no adhesions; and, what is not the least important, if the patient is sanguine of her recovery.

On the other hand, when the general health has been greatly broken down by long-continued irritation; when there is reason to believe that the tumor is multilocular, its contents gelatinous, and its walls bound to the parietes and the viscera of the abdomen by adhesions; and when, withal, the patient is depressed and despondent, the prospect of recovery is greatly lessened, though still by no means hopeless.

Adhesions are present in about one-fifth of all cases of ovariectomy. In the table given on page 811, which embraces 5153 operations of this kind, adhesions existed in 975 cases, and no adhesions in 548.

The influence of such attachments on the mortality of the operation is considerable. Of the 975 cases just referred to with adhesions, 662 recovered and 313 died,—a death-rate of 32.01 per cent.; while in the 548 without adhesions, 434 recovered and 114 died, or a mortality of 20.08 per cent.

The place in which the operation is done exerts an important influence on the results of ovariectomy. Of 1916 operations, 1416 were performed in hospitals, with a death-rate of 35.09 per cent., while of 500 done in private, the mortality was 22.06 per cent.

Again, antiseptics greatly lessens the mortality. Nothing can more forcibly illustrate this statement than the statistics of Keith. In the last 100 cases operated on by this surgeon under spray, 97 recovered, and in 75 successive operations he had not a death. In Germany, where the success of ovariectomy has not been so good as in other countries, the mortality by means of the antiseptic treatment has been reduced from 90 to 20 per cent.

Mr. Wells, whose ovariectomies at present amount to 1000, and whose success is only exceeded by that of Mr. Keith, it is proper to say, does not attach much importance to antiseptics.

TREATMENT.—Except through the methods of surgery, there is no way of deliverance open to a woman suffering from ovarian disease.

The plans which have been employed are tapping, drainage, injection, and extirpation.

Tapping.—This, the most ancient method, is performed by means of a trocar and canula, and can only be regarded as a palliative measure. The operation can be executed when the fluid is thin by an ordinary hydrocele trocar, but when the contents are thick, a larger instrument will be required (Fig.

FIG. 1509.



Trocar for tapping an ovarian cyst.

1509), having a branch to which a piece of rubber hose can be attached for conducting the liquid into the vessels for its reception.

The aspirator, from the little risk of air entering the sac when it is used, should be preferred to all other instruments for tapping, when not contra-indicated by the character of the contents of the tumor. The position which the patient should occupy is either sitting upon the edge of the bed, supported by pillows placed against the back, or reclining on the side or on the back in bed, with the head and shoulders raised, the last being in most respects to be preferred. The place for making the puncture is about two inches below the umbilicus, in the median line, the skin having been incised to remove the resistance to the passage of the trocar, and the bladder emptied before puncturing the walls of the abdomen.

When fluctuation cannot be detected over the course of the linea alba, and can be discovered elsewhere, this rule must be departed from, and the trocar introduced where fluctuation is most distinct, only taking care to avoid the position of the deep epigastric and circumflex iliac arteries. To facilitate the flow of the fluid, and to supply to the viscera the support lost by the removal of the liquid from the cyst, a many-tailed bandage should be placed around the body and tightened as the evacuation proceeds, on the completion of which, and after the removal of the canula, the opening should be covered with a strip of adhesive plaster and the tails of the bandage pinned together. When the tapping is performed with the patient on the side or on the back, the bandage will be unnecessary.

When the tumor is multilocular, it will be necessary, in order to empty the sac entirely, to re-enter the trocar, and, by changing its direction and pushing it forward, puncture other cysts or compartments of the tumor until all have been exhausted of their contents.

Though I have tapped many ovarian tumors, I have never witnessed a death from the operation; and I am unable to understand why so formidable a mortality as that usually given by authors should occur. May it not be attributed to the use of the large trocar, by which the opening in the sac is made too great, and to the sitting posture of the patient, both of which factors expose the peritoneum to the risk of contact with the sedimentary residue of the sac?

Cases of permanent cures following tapping have been given in numerous instances; but, while it is not to be denied that some are genuine, there is great reason to believe that the majority were not ovarian tumors at all, but cysts in the broad ligaments, which cysts are known frequently to disappear after being tapped.

Tapping through the vagina.—When the tumor presents strongly at the upper part of the vagina, and when, on percussing the body of the growth over the abdomen, fluctuation is felt by a finger placed against the projecting cyst in the vagina, the cyst should, preferably, be tapped through the latter. The advantages of making the puncture in this location must be evident, as not only is the sac more completely drained than when opened through the abdomen, but there is also little or no danger of the fluid subsequently entering the peritoneum. It has been observed, too, that after tapping through the vagina the tumor refills more slowly, or may even undergo a spontaneous cure. In one case where I selected this route for tapping an ovarian sac, the accumulation did not recur for many months. Callisen, it is stated by Kiwisch, was the first to perform tapping through the vagina, in 1775.

In operating through the vagina, the patient, after having the bladder and rectum emptied, is placed on her back, with the head and shoulders raised and the limbs drawn up and flexed on the abdomen. The operator, seated in front, introduces the index finger of one hand into the vagina until its extremity touches the most prominent part of the enlargement; then with the other hand a long trocar, with the point drawn within the canula, is conducted along the guiding finger to the protruding part, when the point of the instrument is thrust out and forced into the sac. On the withdrawal of the trocar the fluid can be received into a vessel properly placed below the pelvis. After emptying the cyst, the patient is to be placed in bed and kept

quiet for three or four days. Spencer Wells and others report cures following tapping; though the most that may be looked for is palliation.

Tapping through the rectum is no longer practiced, the procedure being open to the risk of fecal or aerial extravasation into the sac.

Drainage, introduced by Kiwisch, consists in puncturing the cyst by a trocar, either through the abdomen or through the vagina when the latter operation is practicable, and, after evacuating the fluid, introducing through the canula, before its removal, a drainage-tube. Noeggerath modifies the operation by expanding the vagina with a Sims speculum, and cutting through the upper extremity of the canal and the peritoneum until the sac is reached, which, being drawn through the incision, is opened freely, when the edges of the orifices thus made in the sac and the vagina are sutured together, establishing a fistulous opening for draining away the liquid contents of the tumor. The sac is also injected, as occasion demands, with antiseptic agents through the fistula. Though Noeggerath has found even endogenous multilocular cysts disappear by this method, the plan is best suited to cases of unilocular tumors, the walls of which can collapse when once emptied.

Injection has been practiced by Denman, Alison of Indiana, Boinet of Lyons, Baker Brown, and others. The substances employed were solutions of zinc and tincture of iodine, with iodide of potassium and water. The contents of the tumor being drawn off by a trocar and canula, a gum catheter is conducted into the sac by means of the canula, and the particular liquid selected is injected by means of a syringe fitted to its extremity, and, after being allowed to remain for fifteen or twenty minutes, is permitted to run out.

The testimony of practitioners as to the curative value of this method, and as to the absence of danger from the iodine, is very conflicting.

Thomas has tabulated 347 cases of ovarian disease treated by injection, which comprise the collections of Boinet, Cazeaux, Gunther, Simpson, Scanzoni, West, Tyler, Smith, and Peaslee. Of this number, 117 are reported as cures, 95 failures, 79 deaths, and 56 doubtful. As in drainage, the cases deemed best adapted for injection are unilocular cysts whose contents are not thick and tenacious and which have not been the subjects of inflammatory attacks. It is not improbable that if the viscid, gelatinous material which so often adheres to the inner wall of the cyst could be destroyed, injection might, in properly selected cases, become a recognized mode of cure. Dr. Coates, of Leadville, Colorado, has furnished me the particulars of a case of ovarian dropsy which he successfully treated by the injection of eight ounces of the tincture of iodine, having cleansed the inner wall of the sac previous to injection by washing it with a strong solution of bicarbonate of soda.

Incision was first performed by Le Dran in 1836, and consists in dividing the abdominal walls and the sac, and keeping the wound open by packing with lint, at the same time stitching together the parietes of the abdomen and the cyst, should no adhesion between the two already exist. The operation is not likely to receive a very extended professional sanction.

Excision, an imitation of an occasional natural cure by the rupture of the sac, allowing the fluid to escape into the cavity of the abdomen, was first performed by Guérin, and soon after by Bainbridge and by Jeaffreson. The operation consists either in puncturing the sac with a large trocar, and then closing the opening in the abdominal walls, or in exposing the cyst by an incision through the parietes of the body, dragging a portion of it through the opening, and, after excising a piece, pushing the tumor back and sewing up the abdominal wound. Such an operation can rarely be called for.

Ovariectomy.

The possibility of excising ovarian cysts had been considered as early as 1685, by Schorkopff, and in France had been brought before the Royal Academy of Surgery in 1776. Laumonier, a French surgeon, it was supposed had actually, through a mistake as to the nature of the disease, re-

moved an ovarian cyst; but it has been satisfactorily shown that the tumor in question was an abscess connected with the Fallopian tube of the ovary, and not cystic.

To Dr. Ephraim McDowell, of Kentucky, the world is indebted for ovariectomy, one of the boldest operations within the domain of surgery, which this eminent man first performed in December, 1809, on the person of Mrs. Crawford, with entire success. McDowell's cases of ovariectomy amounted to 13, with 8 recoveries. Twelve years later, in 1821, Dr. Nathan Smith, of New Haven, removed, successfully, an ovarian cyst from a patient, the mother of several children; and this was followed, in 1829, by an operation performed by Dr. D. L. Rogers, of New York, the patient recovering; after which come the names of the two Atlees, Peaslee, Kimball, and Dunlap.

In 1819, Chrysmar introduced the operation into Germany, where it was soon espoused by Dieffenbach, Heyfelder, and others. In 1827, Dr. Granville, of London, attempted to extirpate an ovarian cyst, but was compelled to desist on account of extensive adhesions. The first operation of the kind which was completed in London was by Mr. Phillips. The patient did not recover. The first successful removal was accomplished in the same city in 1840, by Mr. Walner. In England, however, ovariectomy was commended to the attention of British surgeons in 1840, chiefly through the advocacy of Dr. Clay, who was supported by Lane, Spencer Wells, Baker Brown, and others. Lizars, in 1825, made an unsuccessful attempt to remove what he erroneously supposed to be an ovarian tumor. In Scotland, Keith—perhaps the most successful operator in the world—may be regarded as the representative ovariectomist.

The history of ovariectomy is an instructive one. It not only inculcates a lesson which rebukes professional dogmatism and all prejudgments based on meagre data, but also demonstrates the heroic and dauntless spirit of those men who were willing to brave the storm of adverse criticism and censure, and who, sanguine of ultimate triumph, surmounted every difficulty, until finally opposition was silenced and universal commendation extorted. Dieffenbach condemned the operation, Kiwisch leveled against it a battery of statistics, and Seanzoni took sides with the opposition. In America, also, very distinguished names were found among the objectors.

OPERATION, PREPARATIONS, ETC.—The time, the place, the preparatory measures, the operative arrangements, the instruments, the technical details, and the after-treatment are all subjects demanding special consideration.

Time for operation.—It is impossible to construct a rule on this point which shall govern all cases. Some contend that the operation, on account of its gravity, should be delayed until the health of the patient begins to suffer, as will be seen by the emaciation and loss of strength, and by the development of dyspeptic symptoms and other evidences of derangement of the internal organs, due to mechanical pressure. It is thought that by such a course the system acquires an increased degree of resistive power against morbid influences, and that the peritoneum, by being subjected to the friction of the tumor, is rendered more tolerant of injury. On the other hand, some advocate operations done before the health declines, and before adhesions have formed between the tumor and the walls of the abdomen or its contents; and with this latter class of surgeons I entirely agree. An additional incentive to early operations is the avoidance of the mental anxiety and worry, which keep the woman constantly under a degree of excitement and suspense calculated to lower her vitality.

Place.—A general hospital ward is not a suitable place for a patient who is to undergo this operation. A private apartment or a small ward is preferable, well ventilated, with an open fireplace which can be used in cold weather for preserving the proper temperature of the room,—that is, about 75° or 80° Fahr.; it should have an exposure which will insure an abundance of sunlight.

Preparatory measures.—These consist in securing a healthy action of the

secretory organs, as the liver, kidneys, and skin. To this end the bowels must be emptied of all accumulations by a gentle cathartic, the renal organs increased in activity by the administration of some diuretic, as infusion of digitalis or Basham's mixture, and the cutaneous organs stimulated by a warm or hot bath followed by friction of the surface of the body.

The patient will do well to remain quiet in her apartment for a few days before the operation, in order to become accustomed to the constraint or quiet which must be enforced for some time succeeding the operation. The diet must be simple and unirritating, consisting of milk, oatmeal, and bread and butter, with meat once a day. Sleep must be induced by bromide of potassium or chloral, or, if these fail, by administering a dose of deodorized laudanum at bedtime. The habitual employment of opium to procure rest is to be avoided, but it will prove of great value for one or two nights preceding the operation, provided the patient is indisposed to sleep. On the morning of the day of the operation the intestines must be opened thoroughly by a large enema of warm water containing one or two tablespoonfuls of salt, or, in the event of there being any flatulent distention of the bowels, by an injection of flaxseed-tea and turpentine.

The dress of the patient at the time of the operation should consist of a flannel undergarment, and over this a night-gown, the lower extremities being covered with stockings and drawers.

A clear, bright day is always to be preferred, but the operation, after being fixed for a given time (mid-day the best), should not be postponed merely on account of the weather. The bed on which the patient is to lie should be a single one and covered with a firm mattress. The operating-table must be narrow, placed fronting a window, and covered with two or three comfortables, over which is to be spread a muslin sheet, with a rubber- or oil-cloth for the purpose of protection. A bucket or tub to receive the contents of the sac should be placed under the table.

Instruments.—As it is impossible to know before the sac is opened what complications may be encountered, it is the part of wisdom to be prepared for all emergencies. The following instruments, therefore, should be laid in a shallow tin vessel containing carbolyzed water, and placed on a small table convenient to the operator: an ordinary scalpel for incising the abdominal parietes and dividing strong adhesions, etc.; a pair of dissecting forceps; a grooved director on which to raise the layers of tissue to be incised; a few *serres-fines*, and a tenaculum to secure small vessels which bleed in the external wound; a steel sound for passing between the tumor and the walls of the abdomen in search of adhesions; and a large trocar (Fig. 1510) with

FIG. 1510.



Trocar for tapping ovarian cyst after exposing the tumor.

gum hose attached, for the purposes of puncturing the cyst and of conveying the fluid contents into the vessel beneath the bed. There are several patterns of this instrument, namely, that of Wells (Fig. 1511), which is armed with claws to grasp the sac and to keep the sides of the puncture in close contact with the instrument, and thus prevent the escape of the fluid between the sac and the canula; that of Hodge, which combines in one the canula and the trocar, the extremity of the former having a point similar to the needle of a hypodermic syringe; and that of Mears, which has a short arm capable of being bent at any angle with the rest of the instrument, on which movement depends the interruption or continuity of the canal of the canula. I have used all these varieties of instruments, and am disposed to

believe that the one shown in Fig. 1510 answers every purpose. In addition there will be required two pairs of vulsella for seizing and drawing the sac out and keeping it close to the walls of the canula, clamps for securing the

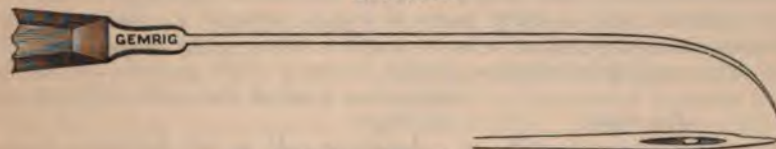
FIG. 1511.



Wells's trocar.

pedicle, cautery irons, strong, carbolized silk thread, and, for the same purpose, silver wire, and a number of strong needles, straight and curved, for introducing sutures. The needle which I find most convenient for this purpose is similar to that which I use for sewing up the perineum or for ligating piles. (Fig. 1512.)

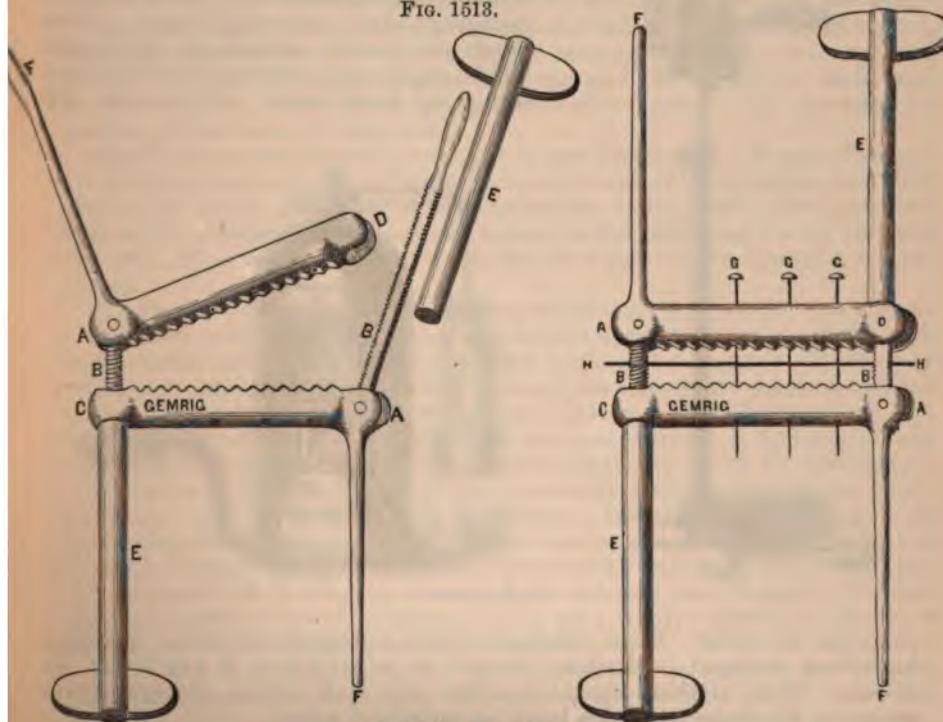
FIG. 1512.



Needle for sewing up the parietes.

There are several clamps in use, examples of which are given in Figs.

FIG. 1513.



Atlee's clamp, open and closed.

1513 and 1514. The one designated as Atlee's is perhaps the most desirable.

Besides the instruments specified, it will be necessary to have carbolized cat-gut ligatures for such vessels as bleed on separating adhesions; pieces of soft

FIG. 1514.



Wells's clamp.

linen, well carbolized, upon which to spread portions of the omentum which require to be brought out of the abdomen; a number of soft sponges, thoroughly deprived of all foreign substances and kept in glass-stoppered jars; sponge-holders; antiseptic gauze and cotton to apply over the surface of the wound when closed; a broad flannel bandage or band to envelop the body; and, finally, a large bucket of carbolized water (one part of carbolic acid to forty parts of water), several tin basins, a vessel into which the soiled water is to be thrown, and a spray apparatus. (Fig. 1515.) The antiseptic solution should be made with phenol, the strength being one part of the acid to thirty parts of water.

FIG. 1515.



Assistants.—It is not desirable to have more assistants present than are necessary for the proper performance of the operation. Five will be sufficient. To one is committed the anæsthetic; one is to aid in sponging and tying bleeding vessels; a third hands and receives instruments; the fourth will be employed in removing the soiled and furnishing clean water; and the fifth will



Spray apparatus.

supervise the spray. These assistants should not on the day of the operation have been engaged in dressing wounds or in attending to any infectious disease. Their clothing should be clean, and each should, preparatory to assuming his duties, wash his hands in carbolized water.

OPERATION.—Everything being prepared, a chair is to be placed at the lower end of the table and a blanket spread over both. The patient being

placed on the table with her feet resting on the chair, and with the head and shoulders somewhat raised on pillows, her garments are to be rolled up above the waist in order that they may be kept dry, after which the blanket is to be wrapped about the limbs and the administration of the ether begun. The spray apparatus, placed on a stand in front of the table, must be regulated in such a manner that the vapor will be directed upon the parts to be incised. The operator now takes his position on one side of the patient and places his first assistant on the other, while the rest are disposed in such a manner as will enable each to perform his part without obstructing the light or interfering with the duties of the others. As soon as the patient is etherized, the bladder should be evacuated with the catheter, after which the formal operation begins. This may be divided into four parts,—namely, dividing the abdominal walls; tapping the cyst, separating any adhesions which exist, and tying bleeding vessels; securing the pedicle; and closing the wound.

(1) *Dividing the abdominal walls.*—The incision must be made exactly in the median line, and between the symphysis pubis and the umbilicus, but nearer to the former. It should be short at first, not exceeding two inches in length. The layers of the parietes are to be divided with the scalpel alone until the muscular aponeurosis is reached, which should be raised on the grooved director and incised. The recti muscles being next separated, some cellulo-adipose tissue will be exposed, under which lies the peritoneum. Any vessels which bleed must be secured either by the animal ligature or by the *serres-fines* before the serous membrane is divided. Just at this stage of the operation a grave error may be committed. Mistaking the peritoneum for the walls of the cyst, the inexperienced operator may begin to peel the former away from the walls which it lines. A little attention will prevent the commission of this blunder. The peritoneum is covered with some fatty tissue, and is much thinner and not so pearly white as the wall of the cyst.

The peritoneum being next laid open to the extent of the external wound, the dense, whitish sac of the tumor will be brought into view. A steel sound should then be introduced between the sac and the abdominal walls and swept round, so as to detect the presence of adhesions over the anterior portion of the tumor, if any exist.

Should any ascitic fluid be present, it is now discharged. If any adhesions are found to connect the cyst with the anterior wall of the abdomen, and they are not too strong, they may readily be broken up by passing the hand, first thoroughly cleansed of all blood and dipped in the carbolized water, between the two. If none are found to exist, the first part of the operation is completed.

(2) *Emptying the sac.*—The second step consists in tapping the cyst and removing its contents. The trocar and canula are plunged through the wall of the tumor into its interior, at the upper angle of the wound, and the trocar withdrawn, when the fluid will flow through the tubing into the vessel placed at the foot of the table for its reception. It is now that the vulsellum can be used with advantage by seizing the sac and holding it forward on the canula so as to prevent the fluid from entering the cavity of the abdomen.

If the sac is a unilocular one, it will be entirely emptied through the single puncture; if multilocular, it will be necessary, after evacuating one, to push again the point of the trocar beyond the canula, and, changing its direction, thrust it through another cyst, and so on, until all have been drained. While the contents are flowing, the hands of an assistant may be applied on each side of the wound in the parietes, keeping up a steady pressure on the walls as they follow the receding or collapsing sac.

When the cyst is multilocular and its contents so solid as not to pass through the canula, they must be removed by the hand, introduced and used as a scoop through a large opening made in the sac for this purpose. As soon as the cyst has been emptied, it is to be drawn by the vulsellum through the external opening until brought outside of the body, which, in the

event of no adhesion existing, can be done without difficulty. The pedicle will thus be exposed and ready for treatment.

Should adhesions fasten the tumor to surrounding parts, they must be detached. If these bands are extensive and strong, if they are found uniting the sac with the large intestines, the liver, uterus, bladder, or omentum, or if the tumor is multilocular and filled with endogenous cysts, in consequence of which it does not collapse, it will be necessary to prolong the incision upward through the walls of the abdomen even above the umbilicus, or to any extent which will enable the operator to see distinctly what he is doing.

Many of the adhesions can be broken up by the fingers alone, always observing to keep close to the wall of the cyst. Some which are dense will require to be touched with the edge of the knife, after which the separation can be continued with the fingers or the handle of the scalpel. Always before breaking up these false bands a careful inspection of their attachments should be made, to see exactly to what the adhesion is fixed. Any neglect of this kind may result in the laceration of a large vessel, or possibly of the intestine or ureter. While the process of separation is in progress, every vessel which continues to bleed must be tied with the catgut ligature, and the blood or other fluid carefully mopped out of the cavity of the abdomen or pelvis by repeatedly using the carbolized sponges. When all adventitious connections have been separated and the tumor turned out, the next step is to secure the pedicle.

(3) *Securing the pedicle.*—On this subject ovariologists are not agreed. The methods most commonly adopted for treating the pedicle are by the clamp, the ligature, the cautery, and the *écraseur*.

When treated by the clamp,—the invention of Mr. Hutchinson, of London,—the pedicle, puckered into as small a space as possible by being surrounded with a stout ligature, is inclosed between its two branches, which are screwed tightly together, thus closing the vessels, after which the condensing cord above the clamp can be removed. The sac is then cut off above the clamp, when the latter is placed across the external wound outside of the abdomen.

Ligature.—The ligature, when used to secure the pedicle, is employed in different ways. *First*, by transfixing with a double ligature and tying the two halves separately, cutting off the cyst, and securing the stump between the lips of the wound by passing a strong pin through all three. *Second*, by placing the stump, after being tied, in the wound, and covering its extremity with the skin, as done by Storer. *Third*, by returning the pedicle, after being tied and the sac cut away, into the abdomen, and bringing the threads out at the lower part of the wound, as advised by Clay; or through the vagina, an opening being made in the upper extremity of that canal for the purpose,—the plan of Greene. *Fourth*, by tying—the method of Tyler Smith—with a double ligature, cutting off both ends, and, after severing the sac, returning it into the abdomen,—a procedure which is adopted by Peaslee, Kimball, and Goodell, and which I have also practiced with success. The animal ligature has been used as a substitute for the silk thread in constricting the pedicle. Wire has also been used for the same purpose by Emmett and others.

The peritoneum has in some instances been drawn over the end of the stump and united by sutures.

Cautery.—The cautery, employed by Baker Brown, and at present by Mr. Keith, is applied by first embracing the pedicle with a clamp, then burning off the sac immediately above with a cautery iron, not raised to even a dull-red heat, after which the clamp is removed, and the edges of the stump carefully smoothed off* by repeated passes with the hot (but not red-hot) iron, when the pedicle is restored to the cavity of the abdomen.

Écraseur.—Atlee at one time was an advocate of the *écraseur* in severing the pedicle, the extremity of which he afterwards treated with persulphate of iron.

* Sims's pamphlet on ovariectomy, by Keith.

Wells and Atlee were notably the champions of the clamp; and when a man counts his operations by the thousand, as was the case with the first-named gentleman, his opinion is entitled to the highest respect. Keith espouses the cautery, and its claim to professional confidence is based on a success in his hands which is unparalleled. In this country it received the sanction of Sims and White.

The merits of these different methods were formerly the subject of considerable diversity of opinion. In contrasting the relative success of the internal and external treatment of the pedicle by the clamp, the ligature, and the cautery during the pre-aseptic period, we find the following results: in 875 cases treated by the clamp the mortality was 21.25 per cent.; in 746 treated by ligature and dropped back into the pelvis, the death-rate was 32.17 per cent.; and in 66 subjected to the cautery and returned into the abdomen, the mortality was 9.09 per cent. In my opinion, as in that of most operators, there are three modes of dealing satisfactorily with the pedicle, namely, by the clamp, by the cautery, and by the aseptic silk ligature, the stump being restored to the abdomen, and the thread cut off close. The clamp, if used, is best adapted to a long pedicle, and the ligature to a short one.

Animal thread is scarcely trustworthy when the inclusion of a large mass of tissue is demanded, and the *écraseur*, when used for the pedicle, may be followed by hemorrhage.

How the strangulated portion of the pedicle is disposed of after the ligature is a question of absorbing interest. Theoretically, one might suppose that a raw surface and a devitalized stump, when allowed to come in contact with the peritoneum, would act as an irritant and develop a destructive peritonitis. Experience, however, has not verified such a supposition. I believe that all the evil effects spoken of are obviated by the extremity of the pedicle, when dropped back into the body, becoming encysted or encapsulated by a wall of lymph, within which it disintegrates, the products of the disintegration being carried away by the vessels which form in the walls that inclose the membrane. That such is the way in which the pedicle is disposed of will appear evident from a case of my own, in which, in removing a large multilocular cyst, I ligated the pedicle and returned it into the abdomen. The woman progressed without any unusual symptoms, and during my absence from the city was permitted to get out of bed and to sit up on the fourteenth day. A sudden peritonitis followed, from which the patient sank and died in a few days. The autopsy revealed the end of the pedicle surrounded by a wall of lymph, which at one point had ruptured and allowed a creamy-looking fluid to escape through the opening into the peritoneum, from which rent lines of inflammatory lymph could be traced, radiating in all directions.

To return to the operation. If, as sometimes happens, a second cyst exists, connected with the other ovary, it is to be treated precisely like the first. After securing the pedicle and removing the sac, the abdomen should be irrigated with warm water, or a solution of boracic acid, and carefully mopped out with the sponges, so that not a drop of blood or any other fluid is allowed to remain in the cavity. This must be repeated frequently, pressing the intestines and the uterus aside for the purpose, until everything appears dry.

(4) *Closing the wound.*—For this purpose I employ the needle represented in Fig. 1512, the eye of which is situated near the point. The sutures must include all the layers of the parietes, cutaneous, fascial, aponeurotic, muscular, and peritoneal. The needle is entered about three-quarters of an inch from the margin of the wound and near its lower end, and brought out through the peritoneum an equal distance from its cut border. An assistant now passes a silver thread through the eye of the instrument, when the latter is withdrawn, thus conducting the wire through the opening. The needle is then unthreaded and passed through the opposite side of the wound in the same manner, when it is threaded with the peritoneal end of the wire and again withdrawn, thus completing the first suture.

The remaining sutures are to be inserted in the same manner, about half

an inch apart. Each thread is to be left long and its ends twisted together. After all have been inserted, the flat sponge, previously placed underneath to catch any blood which may escape from the punctures, is to be removed, and a last look into the abdomen taken to see that no oozing has occurred, when, if all is dry, the sides of the wound are to be brought together and the wires twisted and clipped off. If blood is detected in Douglas's cul-de-sac, the sponge must be slipped in between the sutures and the fluid mopped out before the approximation is concluded. Many operators prefer a plain needle and an aseptic silk thread for closing the parietes. To prevent any accumulation of fluids in the pelvis, some introduce a drainage-tube, which is allowed to remain hanging out at the lower angle of the wound for a few days, and which, in the event of symptoms of infection arising, can be used as a medium for the introduction of disinfecting liquids into the abdomen, in order to wash out any decomposing fluids. It is better, I think, to delay the closure of the external opening for a short time, to see that no bleeding follows, rather than to insert these tubes. After the sutures have been adjusted, a piece of lint moistened with carbolized oil, or the antiseptic gauze, is to be laid over the wound, and on top of this a sheet of carbolized cotton, all of which are to be held in place and at the same time the walls of the belly supported by enveloping the pelvis and the abdomen with a broad flannel or muslin binder, secured by pins. When the stitches are being introduced, the anæsthetic should be withdrawn and the patient allowed to return to consciousness. She is then to be placed in bed on her back, with bottles containing hot water and wrapped in flannel cloths applied to the sides of the body and the limbs; the weight of the bed-clothing should be supported by a cradle.

AFTER-TREATMENT.—If the operation has been a simple one and not prolonged, there will probably be very little shock, in which case nothing is required but absolute quiet. Thirst is to be relieved by cracked ice, and if the patient is restless an anodyne is admissible.

Should the shock be great, every effort must be made to secure reaction by external warmth and by the cautious use of enemata of brandy. A common after-effect of the anæsthetic and the operation is vomiting. This is sometimes very obstinate. It is best relieved by sinapisms over the epigastrium, by an occasional mouthful of hot water, or by carbonic acid water, and often by ice. If these remedies fail to overcome the retching and vomiting, a hypodermic injection of morphine may succeed. In instances of protracted gastric irritability following ovariectomy I have seen good effects from the administration of minute doses of calomel and morphine repeated at short intervals,—for example, one-eighth of a grain of the mercurial with one-thirtieth of a grain of morphine every hour.

The urine must be drawn three times in the twenty-four hours for the first six days, after which the patient may pass it. The bowels need not be opened for seven or eight days, and then a motion will be best secured by an enema of soap and water, or, if there is much flatulence, by one of flaxseed tea and turpentine.

Diet.—For the first three days the patient should be allowed only a tablespoonful of milk, with a little lime-water, once every three or four hours. Small pieces of ice may be used without much restriction. After the third day the quantity of milk can be increased, and some beef-tea may be allowed. If everything progresses well, the sutures can be removed at the end of eight or nine days, and the patient allowed to sit up for a short time after the lapse of fourteen days.

Sequels.—The complications which are likely to arise are collapse, hemorrhage, septic poisoning, and peritonitis. Shock usually follows immediately after the operation, and, as has been already stated, reaction is best secured by external warmth, the use of stimulating enemata, and the moderate employment of anodynes.

Hemorrhage, should it ensue, is seldom delayed beyond twenty-four hours,

and, when internal and clearly recognized, will require that the wound be opened, the bleeding vessels sought out and tied, and the blood carefully removed from the pelvis before reclosing the external opening. The necessity for such a measure is unfortunate, but there is no alternative. If the bleeding proceeds from the stump, it should be uncovered and touched with the actual cautery.

Septæmia is not likely to occur earlier than the fifth or later than the fourteenth day. In most instances the infection is to be attributed to the decomposition of blood or other liquids which collect in the cavity of the peritoneum; and hence the importance of not closing the external wound until it is certain that all oozing has ceased.

The signs of *septæmia* are a frequent pulse, an elevated temperature, great prostration, parched tongue, and mild delirium. Sometimes these signs are preceded by a rigor. Few patients laboring under this affection ever recover. The treatment does not differ from that proper to *septæmia* succeeding other operations.

Peritonitis.—About twenty-five per cent. of the mortality following ovariectomy is due to peritonitis. The precautions which lessen the probability of *septæmia* are equally influential in preventing inflammation of the peritoneum, in addition to which it is important to maintain a quiet state of the abdominal and pelvic viscera for at least seven or eight days. This indication will be fulfilled by the frequent use of the catheter and by the very moderate use of opium in some form.

The symptoms which reveal peritonitis are extreme abdominal tenderness and distention, with a frequent, hard, and contracted pulse.

The prognosis in a case of peritonitis will be extremely gloomy. Opium, hot poultices over the abdomen, and stimulants if the prostration is very marked, constitute the remedies at our command. The local abstraction of blood is generally contra-indicated by the accompanying prostration.

The following tables, embracing an analysis of 5153 cases of ovariectomy collected by Dr. Baum, present in a condensed form the leading and most interesting features connected with this operation.

Table containing an Analysis of 5153 Cases of Ovariectomy.

	Cases.	Recovered.	Died.	Percentage of Mortality.
Total.....	5153	3651	1502	29.13
Single operations.....	4969	3531	1438	28.94
Double operations.....	183	120	63	34.42
Triple operation.....	1	0	1	100.00
Twice on same patient.....	15	12	3	20.00
During pregnancy.....	21	17	4	19.05
During septicæmic fever.....	40	36	4	10.00
Tumors extirpated per vaginam.....	5	5	0	0.00
Adhesions.....	975	662	313	32.01
No adhesions.....	548	434	114	20.80
Treated in hospital.....	1416	909	507	35.09
“ in private.....	500	387	113	22.60
“ in nursing homes.....	49	35	14	28.57
Pedicle secured by clamp.....	875	689	186	21.25
Ligated and dropped into the pelvis.....	746	502	244	32.71
Ligature left outside.....	309	187	122	39.48
Cautery.....	66	60	6	9.09
Cautery and ligature.....	14	10	4	28.57
Ligature and clamp.....	53	36	17	32.07
Pin and ligature as clamp.....	17	11	6	35.29
Enucleation.....	13	10	3	23.08
Silver wire (Sims).....	10	9	1	10.00
Secured to wound by pins.....	15	8	7	46.66
No pedicle.....	5	4	1	20.00
Écraseur.....	4	3	1	25.00
Pin and écraseur.....	1	1	0	0.00
Twisting.....	1	1	0	0.00
Sewed to abdominal walls.....	1	0	1	100.00
Vaginal drainage.....	86	65	21	24.41

Ages, with Number of Married and Unmarried, in 1123 Cases of Ovariectomy.

Ages.	Un-married.	Recovered.	Died.	Married.	Recovered.	Died.
Under 15 years.	10	8	2, or 20.00 per cent.	0	0	0
15 to 20 years.	55	41	14, or 25.45 "	2	2	0
20 to 25 "	99	73	26, or 26.26 "	36	29	7, or 19.44 per cent.
25 to 30 "	82	55	27, or 32.91 "	90	68	22, or 24.44 "
30 to 35 "	59	37	22, or 37.28 "	110	85	25, or 22.72 "
35 to 40 "	40	26	14, or 35.00 "	120	80	40, or 33.33 "
40 to 45 "	27	21	6, or 22.22 "	83	60	23, or 27.71 "
45 to 50 "	20	11	9, or 45.00 "	98	69	29, or 28.56 "
50 to 55 "	33	19	14, or 42.42 "	53	35	18, or 33.96 "
55 to 60 "	10	5	5, or 50.00 "	55	42	13, or 23.63 "
60 to 65 "	8	7	1, or 12.50 "	18	13	5, or 27.77 "
65 to 70 "	0	0	0, or 0.00 "	9	7	2, or 22.22 "
70 and upward.	1	0	1, or 100.00 "	5	2	3, or 60.00 "
	444	303		679	492	

In 960 cases of ovariectomy analyzed with a view to determine the influence of the length of the incision on the mortality, it appears that when the incision did not exceed 4 inches the death-rate was 20.68 per cent.; when over 4 inches and not exceeding 6 inches, 23.04 per cent.; when over 6 inches and not exceeding 7 inches, 40 per cent.; and when between 7 and 8 inches, 42.88 per cent. Antiseptic treatment has now greatly reduced the mortality of ovariectomy.

Principal causes of death.—Peritonitis, in 332 cases; shock, 50; septic peritonitis, 12; hemorrhage, 32; septicæmia, 38; exhaustion, 25; intestinal troubles, 13; tetanus, 6.

Hydrops Tubarum, Hydrosalpinx, or Tubal Dropsy.—Dropsy of the Fallopian tube is not a very common affection. It may be unilateral or bilateral. The tumor rarely attains any great size, and is the result of an inflammatory closure of the tube from adhesion of the serous surfaces of the fimbriae, sometimes following pelvic cellulitis, peritonitis, or catarrhal states of the mucous lining of the canal, and occasionally resulting from a twist of the ovary. Both the uterine and abdominal extremities of the tubes may be occluded. The fluid which accumulates is generally clear or yellowish in color, and coagulates on the addition of heat and acids. As the distention of the tube progresses, its walls become attenuated, the muscular layer is separated into straggling bands, and the plications of the mucous membrane are gradually unfolded and stretched, until finally all its normal characteristics of structure disappear. The tumor does not present the appearance of an elongated cylindrical sac, but by doubling on itself assumes a shape not unlike that of a distended colon.

There are no symptoms which enable the surgeon to distinguish between this tumor and any other cyst, either of the ovary or of the broad ligament. A mobility distinct from that of the uterus, and the irregular, nodulated outline,—peculiarities which are said to characterize these growths,—are so common in ovarian tumors that no reliance can be placed upon their presence as a means of diagnosis.

Tubal dropsy may terminate spontaneously by the giving way of the uterine orifice of the tube and the escape of its contents into the womb. When this termination does not take place, the cyst should be tapped by the aspirator through the upper part of the vagina. After the withdrawal of the fluid the disease is not likely to return.

Cysts of the Broad Ligaments.—Cysts of the broad ligaments are met with

either in the canals of the Wolffian body, or, entirely independent of these, between the folds of the peritoneum. They are for the most part unilocular, and in the former situation are rarely larger than an orange; in the peritoneum they attain a much greater magnitude.

These cysts have frequently been confounded with ovarian tumors. The diagnosis of those exterior to the Wolffian body, as pointed out by the late Dr. Washington Atlee, may be established by examination of the fluid contents of the cyst, which are very thin, translucent, sometimes opalescent in the light, and non-albuminous.

TREATMENT.—These cysts are to be tapped, and their contents removed; the collapse of their walls is usually followed by a cure; or, after the puncture, the opening in the parietes of the abdomen may be closed, and the fluid allowed to escape into the peritoneal cavity. As it slowly drains away, the sac gradually contracts and becomes obliterated.

Dermoid Cysts.—Dermoid cysts, sometimes called *histoid tumors*, from the similarity of their contents to the tissues of the animal body, do not, as a rule, attain any great size, seldom exceeding that of a small foetal head.

For a long time these growths were considered to be the products of a conception which had failed to reach the Fallopian tubes, but was retained in the ovary. This view is no longer tenable, as cysts of this nature are not necessarily connected with the ovary. The solution of the question of their growth will probably be found in some defective development of certain portions of the germinal layers of the embryo. These cysts are always congenital in their origin, but may remain quiescent or make little progress until after that sudden evolution which the sexual organs undergo at puberty; or they may be excited to growth by the stimulus of parturition. The contents of these cysts consist of bone, fat, hair, teeth, skin, a porridge-like substance, cholesterin, and various animal products. (Fig. 1516.)

Dermoid cysts are not always found alone, but may exist associated with multilocular tumors of the ovary. There are no symptoms which declare the presence of these cysts, and consequently they are likely to be confounded with ovarian tumors. Dr. Mears, of Philadelphia, removed one from a child six years old, which was, before the operation, supposed to be ovarian. A similar case is reported by Spencer Wells.

Cysts of this kind not unfrequently reveal their true character by contracting adhesions to surrounding organs and discharging into them their contents. Thus, they frequently empty into the rectum, into the vagina, or into the bladder. In one case I witnessed the discharge occur at the umbilicus in a lady several months after delivery. When the disease takes this course, the process of extrusion should be left entirely to nature. Unless dermoid cysts occasion very serious evils by mechanical pressure, it is better not to resort to operative measures.

Ovarian Fibromata.—Fibromata of the ovary are quite uncommon, and when present are prone to undergo a cystic or osseous degeneration. They are the counterpart of similar tumors in the uterus, and cannot be diagnosed with certainty from other tumors of the ovary. Their regularity of outline and slowness of growth will aid in some degree in distinguishing them from carcinoma, while their solidity will furnish ground for not confounding them with cysts of the ovary.

Only when, from pressure, the disease begins seriously to affect the health should an operation (that of extirpation) be contemplated.

FIG. 1516.



Dermoid cyst in the ovary, containing hair, fat, and one tooth.—From specimen in the Museum of the University of Pennsylvania.

Carcinoma, like fibroma, is rare. It is likely to attack both ovaries simultaneously, and is not peculiar to any age, being seen both in the young and in the middle-aged,—the former perhaps being oftener subject to the disease than persons of more mature life.

It is more commonly met with as a secondary disease, following cancer of the uterus, rectum, or more remote organs, and generally conforms in character to that of the primary disease; that is, if the latter is encephaloid, which is most commonly the case, the ovarian carcinoma will be of the same type; this is equally true if the original tumor is an epithelioma, a scirrhous, or a colloid growth.

When carcinoma of the ovary breaks through its envelope—the peritoneum—the disease will extensively invade the latter. Ovarian carcinoma commences in the epithelium of the follicles of the ovary, and as the tumor enlarges it may undergo cystic degeneration.

As a rule, ovarian carcinoma is not well tolerated by the surrounding parts. Growing rapidly, it excites a chronic peritonitis, giving rise to a large accumulation of ascitic fluid in the abdominal cavity, covering the surface of the tumor with soft plastic deposit, and often gluing it to the parietes of the body. The inflammation is likely to extend to the connective tissue of the pelvis.

The diagnosis of ovarian carcinoma will be rendered probable by the existence of a bilateral tumor in both ovarian regions sensitive to the touch, an early accumulation of serum in the cavity of the abdomen, emaciation and loss of strength, and a fixed state of the uterus from an existing pelvic cellulitis.

Little can be done for the relief of a patient suffering from this affection, except in the way of palliation by the use of anodynes.

Sarcoma begins in the connective tissue of the ovary. Like cancer, it is prone to attack both ovaries, is of the spindle-celled variety, rarely round, and may attain a very great size. Its general history, progress, rationale, and other phenomena do not furnish any clue by which it can be distinguished from carcinoma, nor will the treatment differ from that which is proper to the latter.

Enchondroma has rarely been found affecting the ovary. Sometimes this neoplasm has been seen imbedded in an ovarian fibroma.

Tubercular formations of the ovary are uncommon, but occur occasionally in the young as a part of a more general tuberculosis affecting the lungs, kidneys, or testes. The tubercles may be seated both in the stroma and in the serous surface of the ovary.

Hydrocele of the Round Ligament.—The round ligaments of the uterus follow the course of the spermatic cords in the male, terminating in the labia majora. The true peritoneal investment of the ligaments in the adult stops at the internal abdominal rings. From this point downward, along the canal into the labia, the enveloping membrane, though originally a portion of the peritoneum, consists simply of fibrous tissue. When the peritoneum is prolonged through the internal abdominal ring into the canal, the pouch so formed is called the canal of Nuck. When this remains open, a collection of fluid is liable to form in the sac, constituting hydrocele of the round ligament, or a portion of intestine may descend into the canal, forming a hernia. Even the ovary may prolapse into this tubular pouch.

Hydrocele of the round ligament is liable to be confounded with hernia; but the translucency of the swelling, the absence of resonance on percussion peculiar to enterocele, or of the doughy feel of an epiplocele, and, above all, the information supplied by the exploring needle, will enable the practitioner to clear away any obscurity which may exist as to the nature of the enlargement.

TREATMENT.—The treatment consists in puncturing the sac with a delicate

trocár, and, after evacuating its contents, scratching its interior with the point of the instrument before removing the canula, and afterwards applying a compress and a spica bandage, and for a few days the pad of a gently-pressing truss over the canal. Should this plan fail to effect a cure, the sac may be injected with one drachm of tincture of iodine while the patient is in the erect position, pressure at the same time being made over the seat of the internal ring, in order that the fluid may not enter the abdomen.

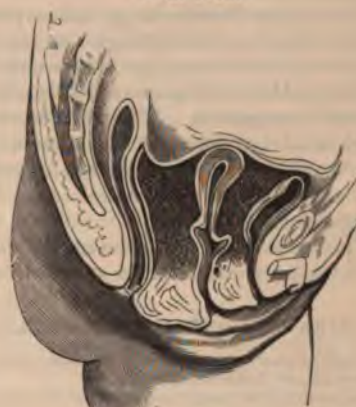
Peri-Uterine Hæmatocele.—Peri-uterine hæmatocele, sometimes described as retro-uterine hæmatocele, is a collection of blood around or behind the uterus, either within or beneath the pelvic peritoneum. When within the serous cavity of the membrane, the blood gravitates to the bottom of Douglas's cul-de-sac (Fig. 1517), and when it is beneath the peritoneum, it infiltrates the connective tissue of the pelvis, extending around the neck and body of the uterus. (Fig. 1518.)

FIG. 1517.



Hæmatocele in Douglas's cul-de-sac.

FIG. 1518.



Subperitoneal hæmatocele.

The credit of first describing correctly the nature of this tumor is due to Nélaton, though his claims to priority have been warmly disputed by Bernutz, who prefers to name this condition peri-uterine hæmatocele.

SOURCE OF THE BLOOD.—This will depend on the situation of the hæmatocele. When the collection of blood is within the cavity of the peritoneum, it is commonly derived from the vessels of the ovary, and occasionally from those belonging to the false membranes of old peritonitis (as pointed out by Virchow), the walls of which have given way. When the extravasation exists below the peritoneum in the cellular tissue of the pelvis, the blood will probably have been derived from the tortuous veins which lie between the folds of the broad ligaments or the vessels around the lower parts of the body of the womb. The opinion once entertained that this blood, when existing within the sac of the peritoneum, is regurgitated menstrual blood, finds, I believe, no advocates at present.

CAUSES.—The causes of peri-uterine hæmatocele are predisposing and exciting.

These hemorrhages usually occur at that period of life when the sexual organs are most active, or during menstruation, or in the course of chronic uterine disease: anything, therefore, which induces an undue fullness of the uterine and ovarian blood-vessels may be considered as a predisposing cause.

The exciting causes are inordinate sexual excitement during coition, mechanical violence, and suppression of the menstrual flow.

SYMPTOMS.—The symptoms of peri-uterine hæmatocele are by no means uniform, a fact which must be ascribed to the manner in which the hemor-

rhage occurs, whether slowly or suddenly. Generally there is experienced, especially in the subperitoneal variety of the hæmatocele, more or less pain in the pelvis, which is at first referred to the region of the ovaries, and is accompanied or followed by a sense of fullness or weight. As the accumulation of blood progresses, the effects of pressure become apparent. Uneasiness or pain will be felt extending down the thighs and to the hips, from the encroachments of the blood on the sacral plexus of nerves. Irritability of the bladder, followed by frequent micturition or by retention of the urine, will be present from the same cause, and so also will difficulty in defecation. When an examination is made through the vagina, the finger detects a tumor, generally posterior to the cervix (rarely anterior), and crowding the uterus against the pubes, so that the former is quite immovable. The tumor is sometimes elastic, at other times hard at one place and soft or doughy at another, according as the blood is found in a fluid or coagulated state. The pains are frequently very severe, even agonizing, accompanied by nausea, pallor of the face, vomiting, a cold skin, and a small, feeble, frequent pulse.

If a large hemorrhage takes place into the cavity of the peritoneum, a tumor may be felt through the abdominal parietes above the pubes. This is not likely to be the case when the hæmatocele is in the cellular tissue of the pelvis, as the resistance which is offered by Douglas's cul-de-sac prevents such upward extension. When the accumulation of blood is large in cases of subperitoneal hæmatocele, the peritoneum may be ruptured and the extravasation of blood escape from the cellular tissue of the pelvis into the cavity of the peritoneum, in which case the two varieties of the affection will be merged into one.

The following phenomena will serve to establish the distinction between an intra-peritoneal and a subperitoneal hæmatocele:

INTRA-PERITONEAL HÆMATOCELE.	SUBPERITONEAL HÆMATOCELE.
Constitutional symptoms very marked; uterus anteverted, or thrust to one side.	Not necessarily so; uterus elevated.
The swelling or tumor discernible at the top of the pelvis.	Tumor low down in the pelvis.
The color or tint of the mucous membrane of the vagina natural.	Purple or red color in consequence of pressure on the veins of the pelvis.
Peritonitis common.	Uncommon.

PROGNOSIS.—The prognosis will depend on the severity of the hemorrhage and its location. Generally the danger is greater in the intra-peritoneal than in the subperitoneal variety.

In the majority of instances the blood is gradually absorbed, requiring frequently many months for its final disposition by this process. Sometimes it finds its way, after a considerable length of time, into the rectum or vagina and is discharged.

TREATMENT.—The indications are to arrest the hemorrhage, to counteract the effects of prostration and alleviate local suffering, and to secure the absorption of the blood. The first indication is most satisfactorily fulfilled by removing all constriction of clothing about the body, elevating the pelvis, and applying an ice-bag or cloths wet in ice-water over the lower part of the abdomen. Vaginal injections of ice-water, with absolute rest, and hypodermic injections of fluid extract of ergot, are also of value in stopping the flow of blood.

To establish reaction and relieve pain, stimulants will be required in moderation, and hypodermic injections of morphia.

When there is much nausea, champagne will prove useful in slaking the thirst and allaying the irritability of the stomach. The extent to which the anodyne should be administered must be determined by the amount of depression and the severity of the pain.

As soon as the urgency of the symptoms is over and the stomach has

become quiet, liquid nourishment will be required, milk and beef-essence being most suitable for the purpose.

The propriety of evacuating collections of blood in hæmatocele has not been overlooked by surgeons. Récamier resorted to operative measures for this object. The evacuation was effected by exposing the bulging portion of the tumor in the vagina and either puncturing the enlargement by means of a trocar and canula, or incising the overlying tissues and turning out the clots with the finger or a scoop. The aspirator might be used for the removal of the more fluid portions of the collection. After emptying the accumulation the cavity is to be washed out once every day with antiseptic injections. The results of operations, however, have been less favorable than those of natural processes, and consequently these practices soon fell into discredit as well as into disuse, so that any resort to operative measures in cases of hæmatocele would now be justifiable only in cases of extreme necessity.

Iodide of potassium is thought by some to exert a favorable effect in securing the absorption of the extravasated blood; but in my judgment time, tonics, and good diet are the chief factors in this process.

A patient who has once suffered from hemorrhage of this nature must be extremely prudent as she approaches her next menstruation, for fear that the attack may be renewed. Therefore it will be highly proper for her to remain quiet in bed for three or four days previous to her monthly periods and during that time for at least two or three subsequent menstruations.

Sequelæ.—Hæmatocele is liable to be followed by peritonitis, pelvic cellulitis, and the formation of inflammatory bands, causing displacements of the uterus, painful menstruation, etc.

Peritonitis will demand the application of turpentine stupes, of hot poultices over the abdomen, warm vaginal douches, and opium internally.

Pelvic Cellulitis.

Beneath the pelvic reflections of the peritoneum, between the broad ligaments, and between the vagina and the uterus, and the bladder and the rectum, there exists a quantity of loose connective tissue, through which run a large number of blood-vessels and nerves, and which serves the triple purpose of supporting the latter, preventing displacement of the pelvic viscera, and at the same time allowing a certain degree of movement between the organs of the pelvis.

Inflammation of this connective tissue is designated by various terms, as pelvic cellulitis by Grailly Hewitt and Simpson, peri-uteritis by Courty, perimetritis by Virchow, and peri-uterine cellulitis by Thomas. Although the disease was undoubtedly recognized by the older surgeons and obstetricians under different names, it is only within the last thirty-five or forty years that it has been correctly described, chiefly through the labors of the French and English.

Some writers, and notably among them Dr. Matthews Duncan, regard these inflammations of the cellular tissue of the pelvis as always secondary to inflammation of the uterus, ovaries, etc. That this is frequently the case no one will doubt; but it is not always so. The mode of blood-supply to the uterus, ovaries, and vagina is not corroborative of such a view, as these organs receive their supply after the cellular tissue has been served. Emmett is disposed to give to phlebitis a prominent place in the causation of the disease. Pelvic cellulitis is more common in married than in unmarried females. It may be either local or general, and, according to Emmett, is more frequently met with on the left side; being situated there in sixty-four out of one hundred and fifty-seven cases. The disease is rare after the menopause.

CAUSES.—Among the causes which give rise to inflammation of the cellular tissue of the pelvis are inflammatory conditions of the uterus and of the ovaries, hæmatocele, sudden suppression of the menses, laceration of the

cervix uteri, injuries to the vagina from the maladroit use of instruments in difficult labors, long retention of the foetal head in the pelvis, and severe concussions of the pelvic viscera.

Puerperal conditions are undoubtedly the most frequent causes of this disease. It also appears occasionally to be hereditary. I recall three sisters, each of whom suffered from the disease, and all after first labors.

SYMPTOMS.—In the acute form of pelvic cellulitis the disease is usually announced by a rigor or chill, followed by fever, the temperature running up to 102° or 103°. Pain is felt in the hypogastric region, and often there is tenderness over one or both iliac regions, possibly over the entire lower half of the abdomen. The contiguity of the bladder and rectum to the inflamed tissue renders urination and defecation painful. In other cases the disease may progress so insidiously that its true nature may pass for some time undetected, causing very little or no pain, and characterized only by an evening exacerbation of fever, with some deep-seated sense of fullness or weight in the pelvis, especially noticeable during defecation or when making any straining efforts.

The physical signs communicate the most decisive information in this affection. When the congestive stage of the disease has terminated in transudation, if a finger is introduced into the vagina and carried up to its source, pressing carefully in different directions on all sides of the cervix uteri, and especially well up towards Douglas's cul-de-sac, increased heat and tenderness of the parts will be detected, and if during the vaginal examination the surgeon employs external abdominal pressure, while the body is raised and the limbs well drawn up, a distinct tumor or hardness may be discovered, circumscribed or diffused, and answering to the plastic infiltration of the connective tissue of the pelvis. Often it will be found that a digital exploration through the rectum, especially when the induration occupies the posterior portion of the pelvis, will convey the most satisfactory information. Later on in the progress of the disease the uterus, especially when the pelvic peritoneum participates in the inflammation,—by no means an uncommon complication,—becomes displaced and fixed, so as often to admit of very little, if any, movement.

TERMINATION.—Pelvic cellulitis, should it not pass into a chronic state, seldom continues longer than two or three weeks, ending either in resolution or in suppuration. When the disease follows the former course, the local and general symptoms gradually disappear, and the uterus assumes approximately its normal position and mobility; or if adhesions have formed, and have become sufficiently organized to resist retrograde metamorphosis, the organ may remain permanently displaced.

In the event of suppuration, the pus is sometimes confined to a single locality, or the abscesses may be multiple, and after a time connect with one another by direct or circuitous routes, until the connective tissue of the pelvis is riddled by the sinuses. The pus finds its way out of the body by various routes, as through the vagina, the bladder, the rectum, the upper intestine, the abdominal walls, or the perineum, by the side of the anus, or through the saphenous opening upon the thigh, and sometimes by some of the openings which lead from the pelvis, as the obturator or ischiatic. In a few instances, instead of a single sinus several are present. A lady under my care has three of these openings on the thigh, two on the lower part of the abdomen, and one alongside of the tuber ischii.

PROGNOSIS.—In a large number of cases recovery ultimately takes place, even though the disease may end in suppuration. In the mean while, however, the patient will probably suffer from frequently-recurring attacks of pelvic distress, chills, and pyæmic fever, with loss of appetite and strength, due to the repeated filling up and emptying of the old abscesses, the walls of which contract very slowly and may not become entirely obliterated for many months, perhaps for years. Even when a case is going on favorably there is risk of the circumscribing barriers of the abscess giving way, allow-

ing the pus to invade other regions, as the iliac, or, even without such accident, an attack of peritonitis may destroy life.

Even when recovery is assured, the remote consequences of the disease are often a source of no small degree of physical suffering to the woman; as, for example, uterine displacements, menorrhagia, dysmenorrhœa, sterility, disorganization of the ovaries, closure or dropsy of the Fallopian tubes, and recto-vesical or other fistula.

TREATMENT.—If the physician is called at the onset of the disease, when the chill, pelvic distress, and fever which mark this stage of inflammatory transudation indicate the mischief that is threatened, wet cups should be immediately applied over the sacro-iliac regions, followed by flaxseed-meal poultices as hot as can be borne and large enough to cover the pelvis and the lower part of the abdomen. The importance of heat as a means of securing the resolution of the inflammation cannot be over-estimated; and its good effects can also be realized with peculiar efficacy when it is applied to the vagina. To this end a large quantity of warm water should be passed every hour or two through this canal, to receive which, as it escapes, a bed-pan must be placed under the nates of the patient. The gravity syringe or bag is admirably adapted for conveniently employing these douches.

While these measures are carried into effect, the constitutional disturbance must be allayed by a combination of refrigerants and of arterial and nervous sedatives, as a tablespoonful every two or three hours of neutral mixture, with one drop of the tincture of veratrum viride and one-sixteenth of a grain of morphia. When the pain is severe, a suppository of one or two grains of opium, or the hypodermic administration of a quarter of a grain of morphia, will become necessary. The value of these remedies will be greatly enhanced by insisting on the most perfect quiet of body and mind.

The diet during this time should consist chiefly of milk, with light broths. If by these measures the acute symptoms are subdued and the disease arrested short of suppuration, the next step is to endeavor to get rid of the effused serum and lymph. I have not been able to discover at this stage of the disease any very marked benefit following the use of those remedies commonly called sorbefacients. I believe the removal of the inflammatory materials will be best effected by continuing the use of hot poultices and vaginal washes, by hot hip-baths, and by supporting the general strength of the patient with tonics and an improved diet, observing to keep the bowels in a soluble state by injections of warm flaxseed-tea or water, or by administering a teaspoonful of the compound liquorice powder at bedtime.

When the surgeon finds himself powerless to arrest the progress of the inflammation, and suppuration ensues, the duty of supporting the system becomes imperative. Accordingly, the diet must consist of such articles as will supply abundant nourishment, as beef-essence, milk, milk-punch, eggs, etc. Heat, so useful in the other stages of the disease, is not less valuable in this, and should be continued, with a view to hasten the maturation of the abscess.

It is now that surgical treatment comes into requisition. The sooner the purulent accumulation can be evacuated externally, the better will it be for the patient, who during its retention is exposed to septæmic or pyæmic infection. And yet it is possible to operate prematurely, before the abscess is safely walled up and separated from the surrounding parts, or before the several depots of pus, which often exist, have, through the melting away of intermediate barriers, become confluent. When, however, the abscess points in a direction accessible to the knife, and the pus is found to be approaching the surface, there is no necessity for delay. An opening should be made at once, and the contents of the sac evacuated. The manner of tapping the abscess will be determined by the place where it points. If in the vagina, it is best to make the puncture with a sharp-pointed bistoury, while the part is exposed to the eye by a Sims speculum. The same course may be adopted when the opening is required to be made through the walls of

the rectum. I have sometimes used for this purpose the aspirating trocar, guiding the instrument to the proper spot along the finger as a guide. If the point of the trocar is kept within the canula until the swelling is reached, there will be no risk in its use in this way. It is, however, desirable that the opening which becomes necessary should be sufficiently large to allow of the constant escape of the pus, and should not close up prematurely: hence the bistoury in these cases is preferable to the aspirator. When feasible, the cure will be hastened by introducing a drainage-tube into the cavity of the abscess, and, by keeping it empty, favoring the contraction of its walls and the obliteration of its cavity. Occasionally the interior of these pyogenic sacs can be advantageously treated by injections of permanganate of potash or tincture of iodine.

When a pelvic abscess communicates with the bladder, the fistula can often be healed by keeping the bladder empty, either by the voluntary effort of the patient, or, where these are prejudicial, by the frequent use of the catheter.

Where several sinuses are present, it will often be found that, when the course is circuitous, by making the route direct to one the others will close. In order to counteract the exhausting effects of a protracted suppuration, it will be necessary, in addition to a well-arranged diet, to administer iron, quinine, cod-liver oil, and stimulants, and, not the least important, to give to the patient the benefit of sea or mountain air.

Gastro-Hysterotomy, or Cæsarean Section.

Hysterotomy (from the Greek words *ὕστερα*, "uterus," "womb," and *τομή*, "section") is an operation by which the fœtus is removed from the uterus by incision, either through the abdominal parietes or through the walls of the womb. The term is often used in a loose sense, and applied to cases of *laparotomy* in which the fœtus is removed from the abdomen either after rupture of the uterus or after extra-uterine fœtation; or is again improperly employed when the child is extruded through the vagina after division of the cervix uteri,—vaginal Cæsarean section.

The term "Cæsarean section" is thought to have originated in a statement made by Pliny with regard to the birth of Cæsar, who is said to have been taken from his mother's womb by a section of the abdominal walls.*

If the narrative is true, the operation was attended by the saving of both mother and child, as Aurelia was living at the time when the Roman Senate, trembling at the successes of the conqueror of Gaul, was maturing plans to destroy her son.

Whether this story is a myth or a fact, no medical writer makes any mention of the operation of "hysterotomy" until the time of Guido de Caulico, who, in the chapter "de extractione fœtus," speaks of the propriety of removing the latter by abdominal section after the death of the mother; and this was also the teaching of Ambrose Paré.

Churchill states that in Great Britain the first to advise the operation while the mother was living was Sir Franklin Ould, in 1742. It is a singular fact that, as in the case of lateral lithotomy, tenotomy, and certain other operations, Cæsarean section was executed first in several parts of the world by ignorant and non-professional persons. For example, it is said by Bauhin that on the continent of Europe a sow-gelder—Jacques Nuferin—in 1482 delivered his own wife in this manner; in Great Britain the first hysterotomy was done by a midwife; in Jamaica by a negro woman on herself, opening her side with a butcher-knife; and in the United States also by a young negro, or quadroon.

The first formal hysterotomy in this country was performed, successfully as to the life of the mother, in Ohio, in 1827, by Dr. Richmond. A second was done by a charlatan in Virginia on a mulatto woman, fatal to both

* Pliny's Natural History, lib. vii.

mother and child. A third operation—unsuccessful—was done in Pennsylvania, in the neighborhood of the town of Northumberland, by Drs. Dougal and Van Valzah. A fourth and a fifth were made in Ohio, by Dr. Estep, in 1833 and 1834, both mothers recovering. In Philadelphia, the operation of Cæsarean section was first performed by Professor William Gibson, in 1835, on Mrs. Reybold, both child and mother surviving. This woman was operated on a second time by the same surgeon, and with a like favorable result. In 1869, hysterotomy was done by Dr. Walter F. Atlee, the mother dying but the child surviving; and in 1880 the operation was twice performed, once by the author, unsuccessfully, on a lady five months advanced in pregnancy, labor having come on prematurely, the expulsion of the fœtus being prevented by the presence in the pelvis of an immovable fibroid, and once under the Porro modification, by Dr. Elliott Richardson, on a dwarf at eight and a half months, saving both mother and child.

The conditions demanding gastro-hysterotomy are such as arise from a deformed state of the pelvis, as in rickets and malacosteon, or from the presence of large tumors or exostoses of the pelvic bones obstructing the passage of the fœtus.

The late Dr. John S. Parry, of Philadelphia, in an analysis of 70 cases of craniotomy performed in pelves whose conjugate diameters did not exceed two and a half inches, the patients having all been under the care of obstetricians of recognized competency, found the mortality as to the mothers amount to 26, or 37½ per cent.,—a fatality quite as great as that resulting from Cæsarean section. Dr. Harris, who has studied the subject of gastro-hysterotomy critically, comparing cases of craniotomy and hysterotomy conducted under like favorable conditions as to operative skill, arrived at almost the same result; that is, in 32 cases of Cæsarean section, 20 women were saved and 16 children,—a mortality of 37½ per cent., against 37½ per cent. as obtained in Parry's comparative analysis. The advantage in this comparison in favor of hysterotomy is obvious, as, though the figures indicating the death-rate to the mother are nearly alike in both, in the Cæsarean operation there is the gain of 16, or 50 per cent., of children. Harris's cases of hysterotomy, also, were not selected ones,—that is, operations done early, before the patients were exhausted; and this is important, as delay adds very largely to the mortality of the procedure.

It would thus appear that when the conjugate diameter of the pelvis does not exceed two and a half inches, Cæsarean section offers a better prospect of recovery than craniotomy.

There are three modes practiced for the extraction of the fœtus through the abdominal walls,—the first commonly known as the Sænger method, the second as the Porro method, and the third styled laparo-elytrotomy.

CÆSAREAN OPERATION.—Sænger method.—The preparatory steps are the same as for an ordinary laparotomy. The incision is made on the median line, extending from the umbilicus to an inch above the pubes. All bleeding points being caught with hæmostats, the abdominal cavity is opened by dividing the peritoneum. Two loops of thread are next passed through the edges of the abdominal wound near its upper extremity. The uterus is next brought out through the opening in the parietes, the edges of which are drawn together by the loops of silk as the organ emerges. A mackintosh cloth (aseptic) is immediately placed between the uterus and the wound, in order to keep all discharges out of the cavity of the abdomen. If the waters have not already escaped, the membranes should now be ruptured through the vagina, and an elastic cord carried tightly around the cervix. The uterus is next incised, and the fœtus extracted by the feet. If the head presents, better turn and deliver. Bleeding from the uterine walls can be controlled by hæmostats. After the extraction of the secundines a drainage-tube is passed into the uterus and vagina, and the walls of the uterus are sutured together by buried sutures of aseptic silk, deep and superficial, the first row including the muscular tissue only, and the second the peri-

toneum previously dissected back a short distance, and after the edges have been turned in, the necessary steps have been carefully executed, no fluids are introduced. The external wound having been sutured, the usual antiseptic dressings are applied over the wound. If flat sponges are properly placed between the uterine cavity, and the parietes properly supported, the operation is safely effected without bringing the uterus out of the vagina.

The materials which have been used as sutures are many and various. Wells employed silk, and brought them out of iron wire, and Meadows, Veit, Routh, and others used animal thread. One woman in America was twice operated on for prolapse of the uterus, and after the lapse of five years, and her uterus closed with silk, she made a good recovery. Operators at present

Porro method.—This differs from the Sängel—that after the extraction of the child the uterus is removed in its entirety, the neck of the organ being severed from the body. The stomach is removed at the lower angle of the wound, and a drainage-cavity and Douglas's cul-de-sac and out-

The Porro operation is peculiarly adapted to dead and decomposing.

I am indebted to Dr. Robert P. Harris for the comparison of old with more recent statistics, the steady improvement in the results of Cæsarean 196 conservative operations have been made, 1888 there were 69 operations,—56 in Continents 13 in the United States, with 8 deaths. Germany has had an extraordinary success, losing 4 women. Since 1882 the operators of Dresden 4 deaths. Austria reports 23 operations in the United States there have been 33 improved C of 18 women,—10 out of the first 16, and 8 on

Prior to 1882, when Professor Leopold, of Sanger operation, many children in Germany there has been a steady reduction, in both fi down to 1889, when out of 90 operations on The reduction in the death-rate may be referred the uterus, and the use of antiseptics.

The Porro method has also improved in the last year. During that year there were 29 operations, with a mortality of 62 per cent.; since that time there have been 115 operations or a death-rate of 22 $\frac{2}{3}$ per cent. In the last year, 1889, only 4 women and 3 children were lost. The total number of cases amounts to 267, with 121 deaths and 1 survivor. In the first 50 operations 30 women were lost. On January 1, 1889, 50 operations were followed with a mortality of 28 per cent. The women referred to bore 10 dead children, and 28 operations in order delivered 26 living and 2

The records of the Sanger Cæsarean section show that out of the first 40 operated on, 15 w the last 40, in chronological order, to the close

In one of the Porro cases twins were extracted in an hour. Chiara and Mangiagalli, at the Salva, saved 5 women and 7 children in 7 operations; Kenhaus, Vienna, Späth and C. and G. Braun saved 29 children in 29 operations.

Of 154 cases of the Cæsarcan operation performed after the old plan, only 55, or 35½ per cent., recovered.

North America, 56 recovered,—a success greater than that resulting from the Porro method.

The Cæsarean section in Great Britain, until lately, has proved singularly fatal. By reference to an early paper by Dr. Harris, it will be seen that in 124 operations only 25 women were saved, and 68 children delivered alive. From 1860 until about 1880 there were 52 cases of the operation, with 12 women saved, or only 23 per cent. This great mortality, of course, was not the result of any want of skill on the part of the operators, but was due to the adverse influences with which all grave surgical procedures have to contend.

An important element in the success of the Cæsarean operation is time. Early operations—those, for example, executed within the first twenty-four hours, before the powers of the woman have been exhausted by fruitless pains—furnish a far more favorable result than those which have been delayed to a later period. Thus, we find, even in old statistics, that of 28 timely operations—those done during the first day of labor—performed in the United States, 21, or 75 per cent., recovered; 23 of the children were removed alive, and 19 of them saved. In the light of this fact, when the conditions exist which warrant the Cæsarean section there should be prompt action as soon as labor has set in. The causes of death in unsuccessful cases of hysterotomy are peritonitis, exhaustion, septæmia, and occasionally convulsions.

LAPARO-ELYTROTOMY.—In this operation the vagina is opened by making an incision above Poupart's ligament through the different layers of the abdomen down to the peritoneum, as in the operation for ligating the iliac artery. This operation, I learn from Harris, has been performed 14 times, with 7 deaths. In 11 the operations were on the right side, accompanied by injury of the bladder in 6. In the 3 done on the left side, the bladder escaped injury. Five of the children were still-born; 1 lived an hour, and 1 several days. The American cases numbered 11, with 7 saved; the English, 2, with none saved; the French, 1, with none saved.

The names of six of the American operators are Thomas, Skene, Gillette, Dandridge, Jewitt, and McKim.

HISTORY.—The suggestion of laparo-elytrotomy was first made in 1806, by Joerg, a German obstetrician, who proposed opening the abdomen in the median line and incising the vagina from the pelvic side of the canal, and, if this was not sufficient for the extraction of the child, prolonging the cut through the os and cervix uteri into the body of the organ. Although this procedure was never carried into practice, the proposal probably led Ritgen, in 1820, to mature a plan for reaching the vagina through the abdomen without opening the peritoneum, which he carried into effect in 1821, though the operator, on account of hemorrhage, was compelled to resort to hysterotomy for the removal of the fœtus before terminating the operation.

In 1824, Louis Auguste Baudelocque, a nephew of the distinguished obstetrician Baudelocque, supposing that this method was original with himself, published a paper on the subject which contained the history of two operations of the kind. In one it was found necessary to supplement the Cæsarean section of the womb, as in Ritgen's case, on account of hemorrhage; and in the other, although the child was delivered through the opening made into the vagina, it was not accomplished without wounding the external iliac artery and requiring the ligature of the primitive iliac vessel. In both cases a fatal termination ensued.

It appears from a letter of Dr. Horner's, written in 1824, before these operations of Baudelocque, that Dr. Physick had suggested the same method as a substitute for the Cæsarean section. In 1837, Sir Charles Bell advocated a similar plan, which is described in his treatise on surgery. As with many other methods in surgery, the subject appears to have been lost sight of for a time, until, in 1870, Dr. Thomas revived the operation by reporting two successful cases. These were followed by the cases of Dr. Skene, who thrice made the operation of elytrotomy; and finally Dr. Gillette extracted a fœtus by the same method without inflicting any damage on the bladder.

OPERATION.—An incision is made one inch above and parallel with Poupart's ligament, commencing at the external abdominal ring, and extending to a point nearly opposite the anterior spinous process of the ilium. The layers of the abdominal walls, consisting of the integument, tendon of the external oblique, internal oblique, and transversalis muscles, are next raised and divided on a director until the transversalis fascia is reached. The structure must now be torn, and the peritoneum immediately beneath pushed upward without being opened. The cavity of the pelvis being exposed, a sound is passed into the vagina, and the wall of the canal made prominent into which a small opening is made, which is enlarged by tearing with the fingers as nearly as possible in a longitudinal direction, or in the long axis of the canal, the object being to avoid hemorrhage. It has been suggested that, in order to prevent bleeding, the opening into the vagina should be made with the galvano-cautery. The thermo-cautery of Paquelin would answer equally well.

The fœtus, having descended, is now to be seized and brought through the opening, after which the placenta should be extracted. All hemorrhage being controlled, and the pelvis carefully sponged dry, the approximation of the external wound is to be made in the same manner as after ligature of the iliac arteries, an operation very similar in its earlier stages to that of elytrotomy. Thomas advocates the use of a drainage-tube, allowing one end to extend into the pelvis, and the other to protrude through the lower angle of the external wound.

The danger to the ureters and the bladder when enlarging the wound in the vagina is unquestionably great, a fact which suggests the importance of entering the canal close to the side of the pelvis. In considering the accidents which have occurred to operators in performing elytrotomy, with the damage which is likely to be inflicted on the ureters, bladder, and vessels of the pelvis, it is apparent that more than common skill is demanded for the proper execution of the task of removing a fœtus by the method described,—so much more, indeed, than that required in the Cæsarean section that it is very improbable that it will ever supplant the latter.

I cannot forbear, after giving the statistics of the Cæsarean operation at the present time, to retain, for comparison, those which Dr. Harris, under difficulties which, I am sure, would have deterred any ordinary investigator, furnished to the profession some years ago. These records embrace 374 cases of gastro-hysterotomy, or Cæsarean section, distributed as follows:

In America, 130; in the United States, 122; in the United Kingdom of Great Britain and Ireland, 122. Of the whole number, 131 women (35 per cent.) recovered and 243 died; and of the children, 134 were saved.

In Continental Europe 1285 cases of the operation have been reported, but so indefinitely that it is impossible to make any reliable analysis of them.

The records of the operation and its results in North America and in the United States, deducible from the data of Dr. Harris, are as follows:

In North America there have been 122 Cæsarean operations, 56 of the women being saved, or about 46 per cent. In the United States there have been 113 Cæsarean operations, 49 of the women being saved, or 43 per cent.

The published cases in the United States amount to 65; the unpublished cases to 57. Of the published cases there were saved 36 women, or 55.4 per cent. Of the unpublished cases there were saved 13 women, or 22.8 per cent. In 28 instances the operations were done on the first day of labor; 14 of the patients were white, and 14 black; 11 whites and 10 blacks recovered,—21, or 75 per cent.; 23 children were removed alive, and 19 of them saved.

In North America, 9 women—4 whites and 5 blacks—were operated on twice.

In all of the 122 operations the uterus as well as the abdomen was incised; consequently all cases in which gastro-tomy was performed for the extraction of a fœtus which had escaped into the abdomen through a laceration in

the walls of the uterus have been excluded from the above collection as not properly belonging to the Cæsarean operation.

Of 24 dwarfs,—17 white and 7 black,—only 7 recovered; 5 of the 7 were operated upon early. These dwarfs measured from three feet two inches to four feet eight inches in height.

Of 17 cases operated upon late, only 2 recovered.

DISEASES AND INJURIES OF THE URETHRA AND BLADDER.

Diseases and Injuries of the Urethra.

Congenital vices of the urethra are not common. The canal may be absent or cleft.

Absence of the Urethra.—In cases of this nature there is a deep depression beneath the arch of the pubes, at the bottom of which is seen the open mouth of the bladder. It may be desirable under such circumstances to construct a canal so as to convey the urine to the anterior surface of the vulva. Emmett, in a case of this kind, accomplished the object by raising two flaps of mucous membrane, one on either side of the median line, and suturing together their raw surfaces by interrupted silver sutures.

Lacerations of the Urethra are sometimes inflicted by falls upon pointed bodies, and are to be treated by closing the laceration over a catheter with interrupted silver sutures. The catheter should be retained in the bladder for four days, or until union has taken place, at which time the stitches should be removed.

Sloughing of the urethra has resulted from phagedænic ulceration of the vagina, but more frequently from the long-continued pressure of the foetal head in protracted labors.

When the destruction is not too great, the canal can be reformed by freshening the margins of the opening, and, as in laceration, bringing the sides together over a catheter, the latter being worn until the union is complete.

Should the loss of substance be too great to permit this, it will be necessary to secure two flaps by making a longitudinal incision on either side some distance from the remains of the canal, and, after turning their mucous surfaces inward, unite the margins of the flaps over a catheter by interrupted sutures.

Obliteration of the Urethra, the result of inflammatory destruction of the mucous membrane, is occasionally witnessed. In one case which came under my care it was associated with a vesico-vaginal fistula, both being produced by the same cause. I first reformed the canal by tunneling the cicatricial issue which occupied its centre or axis by a trocar, and secured its patulous condition by passing bougies daily until the surface healed. The fistula was afterwards closed.

Urethritis.—Inflammation of the urethra occasionally follows a vaginitis, or it may be caused by the rude use of instruments. The disease may be recognized by the extreme red color of the mucous membrane, the swollen condition of the meatus, and the vesical tenesmus and burning, scalding sensation accompanying urination. It is important that the disease should be arrested as early as possible, since otherwise the inflammation tends to creep upward into the bladder and give rise to a serious cystitis.

TREATMENT.—When the urethritis is caused by an extension of gonorrhœal inflammation, our efforts must be directed to the cure of the latter disease, without which all remedies addressed to the urethra alone will prove valueless. With a view to remove the urethritis, the topical application of hot water frequently to the vulva and the use of weak urethral injections of the sul-

phate of zinc (zinci sulph., gr. i to gr. iij; aqua rosæ, ʒi) or of the nitrate of silver (argenti nitras, gr. ʒ to ʒ; aqua destillat., ʒi) constitute the most efficient remedies, together with the free use of alkaline diluents in order to render the urine as unirritating as possible.

Granular Urethritis.—The condition which I term *granular urethritis* consists in a hypertrophied state of the papillæ of the mucous membrane of the urethra, and is commonly met with in females over thirty years of age who have borne children. It is attended with an irritable state of the bladder, the patient complaining of a sense of fullness at the neck of the organ, with vesical tenesmus and extreme ardor urinæ. On examining the urethra, the mucous membrane is found sensitive, somewhat redder than natural, and studded with numerous fleshy eminences.

At one time I was led to believe that nothing short of cauterization by strong mineral acids would avail for the cure of the disease; but a larger experience has taught me that the persistent daily use of graduated bougies, well smeared with an ointment consisting of ten grains of tannic acid, three grains of sulphate of morphia, and three drachms of cold cream, will remove the irritation and restore the mucous membrane to its healthy condition. With a little instruction the woman can herself use the instrument.

Tumors.—There are two kinds of tumors which arise in the course of the urethra, the *polypoid* and the *neuro-vascular*.

Polypoid growths are to be considered as fibromata or fibro-adenomata. They are pedunculated, pyriform in shape, and have their attachment near the mouth of the bladder. They consist almost entirely of delicate threads of connective tissue.

These growths give rise to severe local irritation, occasioning a constant desire to urinate, attended with pain, and frequently offer considerable obstruction to the flow of water. From the position which they occupy in the urethra, the true character of the disease is often overlooked. The only positive evidence of the existence of a polypoid growth in the urethra is that furnished by the sight; and hence, when investigating a case in which the presence of such a neoplasm is suspected, the interior of the canal must be exposed by the dilating forceps.

In removing a urethral polypus the growth should be seized by a pair of forceps and its pedicle put upon the stretch, when it may be severed from its attachment to the walls of the canal, either by long, narrow-bladed scissors, or with the dressing-forceps.

Fibro-vascular tumors, or *urethral hemorrhoids*, are much more common than the polypoid. Though seen at all periods of life, they are most frequently met with in young females. The part of the urethra from which they grow is near the meatus, and consequently they are easy of detection. The tumor lies in or protrudes from the orifice of the urethra, possesses an intensely red color, and is about the size of a pea, its surface being often granular and exceedingly sensitive to the touch. These vascular growths have a sessile base, and frequently bear a strong resemblance to a red raspberry. The irritation, suffering, and vesical tenesmus and distress which attend their presence are quite sufficient in many instances to incapacitate the patient from attending to any duties whatever.

These growths are constituted of fine nerve-filaments and blood-vessels, supported on a framework of delicate connective tissue. The blood-vessels are sometimes so numerous as to give to the tumor an erectile character. The treatment is very simple, and radical in its result. I have removed very many such growths, and have never once witnessed their recurrence.

A tenaculum being passed through the tumor, it is to be drawn well out of the meatus and clipped off with a pair of scissors close to the surface from which it grows. As soon as the bleeding subsides, the site from which the growth has been cut away must be touched with either pure nitric acid

or acid nitrate of mercury, care being taken to neutralize the redundant fluid by injecting into the urethra a solution of nitrate of potash or some sweet oil.

Urethrocele.

This term is applied to two different conditions,—one in which there is a prolapse of the redundant and thickened tissues of the urethra external to its canal, and another in which there is a protrusion of its mucous membrane, forming a red, congested, and spongy mass external to the meatus. Frequently the prolapsed membrane belongs rather to the bladder than to the urethra. The effect of the protrusion is to dilate the canal, and yet the retentive power of the neck of the bladder is not materially impaired. A woman in one of my wards at the Pennsylvania Hospital was admitted on account of a urethrocele which had expanded the passage to a degree which easily admitted the finger into the bladder, and yet there was no complaint of incontinence of urine. In these cases the roll of mucous membrane doubtless forms a stopper for the mouth of the bladder.

CAUSES.—The causes concerned in producing this affection are all those which create straining or tenesmus of the bladder, as cystitis, cystocele, tumors of the urethra, hemorrhoids, pelvic cellulitis, etc.

TREATMENT.—In that form of urethrocele in which there is an excess of peri-urethral tissue, and where the symptoms are sufficiently severe to justify operative measures, the plan adopted for the cure of cystocele, though on a less extensive scale, will be proper.

It is important, before any operation, to remove as far as possible every cause which may be concerned in the production of the urethrocele. After this, when the prolapse is confined to the mucous membrane, the operation must be determined by the extent of the mucous membrane involved. If the disease is limited to that portion near the meatus and only slightly affects the membrane, either on one aspect of the canal or around its entire circumference, unless the local irritation is particularly annoying it will be better not to meddle in the case at all. If, however, the symptoms are urgent, the prolapsed portion may be raised by a tenaculum and cut away.

When the redundant tissue extends all the way round the orifice of the canal, if division alone is employed, the prolapsed membrane must be raised about the urethral orifice and the folds excised at two or three places, in a direction answering to the long axis of the canal. Should, however, the mass be voluminous, it will be better to include it in one or more double or single ligatures, and, after tightening the threads firmly, to cut off the strangulated membrane near the ligatures.

When the prolapsed portion is derived from the circumference of the urethra higher up, and refuses to remain in place after reduction, a very ingenious operation has been practiced by Dr. Emmett, which consists in making a longitudinal slit through the walls of the urethra down to the mucous membrane, then drawing the redundant portion of the latter through the opening, and, after introducing a sound into the canal in order to smooth out its lining membrane, passing a sufficient number of interrupted sutures through the sides of the wound, including the mucous membrane, after which the latter is cut off and the stitches tied.

The same operation will be proper when the prolapsed membrane is derived from the bladder. When the cystocele is the result of a cystitis, all retrenchment of the mucous membrane by operation will be useless, unless the disease of the bladder can be removed, and, with the latter object in view, it may be necessary to establish a vesico-vaginal fistula.

Chronic Cystitis is less common in the female than in the male, but quite as rebellious to treatment.

CAUSES.—Among the causes which are concerned in developing cystitis in the female are vesical calculi, polypi and papillomata in the viscus, displace-

ments of the uterus, retention of urine, cold, reflected irritation from the rectum, as in ulceration, hemorrhoids, or fissure of the bowel, accidents during labor, and exposure to cold. Indeed, any long-continued irritation of the bladder predisposes the patient to the development of cystitis, simply because the alteration in the form of the bas-fond of the organ and the turgescence or hypertrophy of the mucous membrane at its neck, which follow frequently-repeated straining in efforts at micturition, tend to offer an obstacle to the complete expulsion of the urine, so that a portion remaining and undergoing decomposition becomes a direct cause of inflammation. As in chronic cystitis of the male, so in that of the female, the ureters and kidneys are prone to organic changes. The symptoms which characterize the disease are much alike in both sexes.

TREATMENT.—It is of the first importance, in taking charge of a case of cystitis, to institute a careful inquiry, with a view to discover if there exists any cause which is likely to perpetuate the disease, and, when possible, to remove the same. Thus, fissure of the anus, hemorrhoids, vesical or urethral growths, and displacements of the womb, are all irritants calculated to sustain inflammation of the bladder, and, being all correctible, ought to be eliminated from the case by timely operations and by instrumental supports. In this way much relief will be obtained by withdrawing a certain amount of irritation from the bladder. Nevertheless, there will still remain enough in many instances to render the woman, by the incessant worry, smarting, pain, straining, and constantly-repeated efforts at urination, one of the most miserable of human beings.

Injections I was disposed at one time to believe were valueless, but I find those consisting of permanganate of potash and of carbolated water, of the same strength as I have directed for cystitis in the male, to be of much service. Equally important is catheterization, which in the early and indeed throughout all stages of the cystitis should be practiced twice daily, so as to insure the removal of all sedimentary depositions which are not expelled by the voluntary efforts of the patient.

The free use of diluents will also be required to diminish the irritation of the urine. As the latter from its chemical constitution tends to aggravate the local inflammation, it has been thought that by providing for its escape, and thus securing repose to the vesical walls, a cure would be effected. On this supposition is based the operation of cystotomy, a surgical procedure suggested by Professor Willard Parker, of New York, in 1850.

The operation is done by placing the woman on the side, expanding the vagina with a Sims speculum, and, raising the vesico-vaginal wall immediately behind the neck of the bladder with a tenaculum, excising in a transverse direction an elliptical piece of the septum. The division of the anterior wall of the vagina will be facilitated by causing it to be somewhat raised on the point of a metal catheter passed into the bladder. In this way a fistula is established, through which the urine passes into the vagina, and which, although a source of annoyance to the patient, is much more bearable than the suffering that it alleviates. The operation, however, in well-established cases of chronic cystitis, is only palliative.

To prevent the opening from becoming too small and contracted, various plans have been advocated. Emmett recommends a glass stud to be inserted; lead will answer equally well for constructing this contrivance. Pallen has suggested the thermo-cautery of Paquelin, with which to destroy the vesico-vaginal partition; and Bozeman, with the same object in view, cuts out a circular piece. The elliptical opening, which resembles the usual form of accidental vesico-vaginal fistula, answers the purpose quite well.

Irritable Bladder.—This is a very common affection in females, particularly among the higher class of patients. It is characterized by very much the same phenomena as those belonging to cystitis, except that in the former the microscope reveals no pus, ropy mucus, or blood-corpuscles in the urine. Nor

does the irritation appear to affect materially the general health. Women having an exalted nervous organization, who indulge freely at the table, or who suffer from the depressing effects of grief, are those most prone to this affection.

TREATMENT.—Too often this irritability is referred exclusively to psychical causes, and allowed to pass into the more serious condition of cystitis before the true nature of the malady is recognized. It will be found in a goodly proportion of cases that the irritability has indeed a physical and not an imaginary basis; and hence the wisdom of closely interrogating every organ which, from its relation to the bladder, might be suspected of creating trouble, and of inquiring into the habits of the patient. In this inquiry will be considered the possibility of uterine displacements, urethral and vesical growths, calculus, anal fissure, hemorrhoids, composition of the urine, and diet. If in any of the above particulars the patient is at fault, the correction of the defect is of the first importance. Should no such explanation exist for the irritability, the case may be regarded as a neurosis, having its origin in an anæmic state of the system, or in that exhaustion which is induced by protracted anxiety, grief, loss of rest, etc.

Under these circumstances the blood must be enriched by iron, strychnia, quinine, a generous diet, and sea or mountain air. Hot, sometimes cold, hip-baths, with suppositories of opium and belladonna, will allay much of the irritability, and procure rest at night. Bromide of potassium will also be found useful in effecting the same objects. The patient should be urged to lengthen the period (by a few moments) between each succeeding urination. By this plan alone I have succeeded in rendering the bladder entirely tolerant of the presence of its secretion.

Forcibly dilating the urethra and the neck of the bladder has been a popular practice in cases of irritable bladder, and I have frequently adopted this measure when no sufficient cause of the vesical affection could be discovered. The results, however, have been so unsatisfactory that I attach very little importance to the procedure.

Extra-Uterine Pregnancy.

An ovum which, after being impregnated, fails to reach the cavity of the uterus, its development being continued outside of that organ, constitutes what is termed an extra-uterine pregnancy.

CAUSES.—The causes which operate to produce extra-uterine fœtation are such as disturb the true relation between the uterus and its appendages, or in any way induce changes in the form or patency of the oviduct calculated to offer a mechanical barrier to the migration of the ovum. Among these are pelvic or peri-uterine cellulitis, blows over the abdomen at or about the period of fecundation, tumors pressing against the Fallopian tube, and uterine displacements. In a few instances it has occurred in a hernia of the ovary. Some writers, and among them Astruc, Ramsbotham, Baudelocque, and Cazeaux, recognize emotional and moral causes among others, as fear, super-excitement, etc., growing out of illicit sexual indulgence; in confirmation of which Chavasse asserts that irregular fœtations are more common in single than in married women,—a statement, however, which is not sustained by the observation of other writers.

It has been noted, especially by Schroeder, that extra-uterine pregnancy is usually preceded by a period of sterility; that is, when it occurs in primiparæ, a considerable time has elapsed between marriage and the accident; and when it happens in multiparæ, it has succeeded a previous normal pregnancy after an unusual interval of sterility.

Women who have borne children suffer more frequently than primiparæ. Thus, in 500 cases examined by Parry, the number of the pregnancy is mentioned in 351, and of these 279 were multiparæ and 72 primiparæ.

The period of life at which the accident is most common is between twenty and thirty years of age.

Occasionally there is seen both a normal and an extra-uterine pregnancy existing at the same time. This occurs in about 4 in every 100 instances of extra-uterine foetation. Gordon* met with a case in which a woman gave birth to five children while carrying an extra-uterine foetus.

There are three localities in which the impregnated ovum may develop: in the Fallopian tube,—*tubal*; in the ovary,—*ovarian*; and in the abdomen, *ventral*.

The particular portion of the oviduct in which the ovum becomes arrested and grows varies in different cases. It may be where the tube enters the uterus, the walls of the latter becoming expanded over the product of the pregnancy, sometimes called *interstitial* extra-uterine foetation, or the utero-tubal of Blundell; or it may be at any point between this and the ovary.

While all writers are agreed as to the existence of tubal pregnancy, there is considerable diversity of opinion in regard both to ovarian and to ventral pregnancy. The occasional existence of both, I think, may be admitted; though with reference to the latter it is highly probable that ventral foetation is in most instances a secondary result, due to a rupture of a cyst primarily occupying the oviduct or the ovary.

Another interesting subject is the nature of the connection subsisting between the misplaced foetus and the circulation of the mother. There is no deciduous membrane interspersed between the maternal tissues and the radicles of the chorion.

It would appear from the microscopical examination of Braxton Hicks that a plastic deposition takes place on the surface of the membrane with which the ovule is in contact, and that the villi of the chorion become imbedded in this material, the connection, through the subsequent formation of blood-vessels, becoming a vascular and vital one.

Though the cyst inclosing an abnormal foetation, it is believed, is devoid of a decidua, this structure is always formed in the uterus in cases of extra-uterine pregnancy, as though the organ was waiting for the reception of the detained or misplaced conception. The membrane, however, does not remain until the termination of the gestation, but becomes detached, and is expelled from the uterine cavity in fragments,—a fact of some diagnostic importance. Should a foetus thus holding a parasitic life survive until the full term of utero-gestation, it does not, as a rule, materially differ in the perfection of its development from one which has occupied the cavity of the uterus.

The sex of extra-uterine children is almost equally divided between males and females.

PROGRESS AND TERMINATION.—The wall or cyst which incloses the foetus, especially in cases of tubal pregnancy, very often ruptures before the fourth month, allowing its contents to escape and destroying the mother from hemorrhage. Out of 329 deaths from extra-uterine pregnancy, 174, or 52.88 per cent., were due to rupture of the sac. When the above period has been passed safely, gestation will probably advance to full term. After the death of the foetus it is subject to various changes. It may remain quiescent for an indefinite time. In Nebel's† case the patient, who lived over ninety years, had carried the misplaced foetus for fifty-five years; others have been retained from five to twenty years. Goodell operated on a woman at the University Hospital in whom abnormal pregnancy had occurred two years previously. The cyst in this case had become adherent to the anterior abdominal wall, and was quite resonant at the time of the operation from the gases eliminated from the decomposing foetus. Another change is one in which the contents of the sac are converted into a substance like adipocere,

* Western Journal of Medicine and Surgery, October, 1848: Parry.

† Parry on Extra-Uterine Pregnancy, p. 123.

the cyst-wall also undergoing a calcareous transformation, after which both may remain harmlessly attached to the body; or the sac may open into the intestine, penetrating the sigmoid flexure of the colon, or into the rectum, the bladder, or the vagina, or occasionally through the abdominal walls. The late Professor John T. Darby met with a case in which an opening existed between the sac and the stomach. Dr. Mattei* has given the terminations of 100 cases of extra-uterine pregnancies left to nature: 12 of the women, after retaining the conception for several years, died suddenly; 5 died from accidents during the pregnancy without the cyst opening externally. In 37 of these cases an opening was made into the cyst through the abdominal walls; in 21 this occurred spontaneously, of which number 20 recovered; in 7 as a result of operative interference, all recovering; and in 9 by gastrotomy, all recovering. In 8 cases the cyst opened into the bladder, 2 proving fatal; in 7 it opened spontaneously into the vagina, proving fatal in 2; and in 5 the opening was made by the surgeon, followed by 4 recoveries.

Thirty-one of these pregnancies were discharged into the intestinal canal, either spontaneously or by operative interference; 12 of the women recovered and 19 died.

The conclusions which Mattei arrives at from the analysis of his collection are—*first*, that old extra-uterine pregnancies allow of life being prolonged for many years; they amount to about twelve per cent. of the whole number of such foetations, and are likely to become old when the foetus dies early and the cyst remains of a small size; *secondly*, in five per cent. they become the cause of death without the cyst opening externally or into a mucous canal; *thirdly*, in one-third of the cases the cyst, whether opened or not, is expelled; and, *fourthly*, in twenty-eight per cent. the opening, whether spontaneous or artificial, takes place through the abdomen. The analyses of Pusch and Parry do not materially alter the conclusions of Mattei.

Among the first symptoms which are likely to attract special attention is a one-sided pain, occurring towards the end of the first month of the pregnancy, located deep in the hypogastric or the iliac region, and often sufficiently severe to produce alarming prostration. The pain, which rarely continues over twenty-four hours, is replaced by marked tenderness on pressure. These attacks are likely to be repeated at intervals ranging from several days to weeks, and are the effect of nerve-pressure, from the unwillingness with which the structures inclosing the foetus yield. To the above symptoms may be added a bloody discharge from the vagina, caused either by the separation of the decidua or by the rupture of some of the uterine or tubal vessels from over-distention or engorgement.

A case of suspected pregnancy, with such symptoms, ought to suggest the necessity of making a vaginal examination, as the uterus does not remain quiescent, but increases in size in cases of abnormal pregnancy much in the same manner as when the product of conception occupies its cavity.

The vaginal examination may result in the detection of the foetus in its erratic position. Noeggerath advises that when other measures of exploration fail, and the grounds for believing in the existence of an abnormal foetation are plausible, the examination be made by the finger introduced through the urethra into the bladder, which renders both the uterine and the ovarian regions very accessible to the touch. In the more advanced stage of the pregnancy still more decisive signs appear, as the movements of the child and the sound of the foetal heart. Of course these phenomena establish only the fact of pregnancy, without reference to its kind. Often, however, it is possible to trace the outline of certain portions of the foetus through the abdominal walls, and an examination made through the vagina may discover not only a tumor behind the uterus, but also the outlines of a part of the child; conjoined manipulation may at the same time reveal the independent mobility of the latter, and, possibly, its displacement to one side.

Too much importance must not be attached to the knowledge gained by

* Medical Times and Gazette, 1861, vol. II. p. 172.

an external exploration of the abdomen. In a case which I saw with Dr. Stewart of this city, and which was supposed to be one of extra-uterine pregnancy, the configuration of a fetus could be distinctly traced through the parietes, and yet, as the result showed, the child was *in utero*. The introduction of a sound into the uterus would of course determine if its cavity was unoccupied; but in the event of the opposite condition being the case, premature labor would almost certainly follow. The usual enlargement of the mammae, and the sickness belonging to ordinary pregnancy, are not wanting in cases of extra-uterine foetation.

When the fetus is carried to the full term, labor-pains set in as in an ordinary case of mature utero-gestation.

DIAGNOSIS.—The diagnosis of extra-uterine pregnancy must be admitted to be very difficult. Errors have been committed in such cases by men of acknowledged ability. Dieffenbach, in a supposed case of extra-uterine pregnancy, made the abdominal section, when it was found that no pregnancy of any kind existed. The surgeon, therefore, should proceed with the utmost caution, and not enter on an operation of so serious a nature as that of opening the abdomen until he is in possession of the most conclusive evidence that the gestation is abnormal. The earlier the true nature of the case is recognized, the better for the patient. The great fatality attending the most common form of these pregnancies, namely, the tubal, from rupture of the oviduct, will impart force to this statement.

In attempting, therefore, to make an early diagnosis, the general fact of a pregnancy must first be ascertained, and next any circumstances connected with the condition which may be deemed unusual or irregular to normal gestation. It has been shown that, so far as authors on this subject have been able to gather information, women who have been the subjects of extra-uterine foetation have generally been conscious of something peculiar in the signs betokening pregnancy, or, if multiparæ, have noticed symptoms which were altogether different from those which attended previous gestations. For example, the pains have been of unwonted severity, and located in the hypogastric or the iliac region; the exhaustion has partaken more of the character of shock or collapse than of prostration incident to mere nervous perturbation. It is impossible, indeed, for a patient to sink down in a state of syncope, with a pallid face, pinched features, cold extremities, and skin bathed in clammy perspiration, unless something unnatural and grave has occurred. If in addition to these signs there has been a bloody discharge from the uterus, or the fragmentary expulsion of the decidua, there is the strongest ground for suspecting an extra-uterine pregnancy.

Later on in the history of the accident corroborative evidence of the pregnancy can be obtained by vaginal examination, simple or conjoined with abdominal pressure, the patient being under ether; that is, a tumor can be felt by the touch, laterally or posteriorly, located in the pelvis; possibly the outline of a limb may be distinguished; and if the fetus has reached the fourth month the very decisive test of ballottement can be employed, also the exploration through the bladder, as suggested by Noeggerath.

In cases which have advanced to a still later period the physician may have not only the phenomena already described to guide his inquiry, but also those of the sound of the foetal heart and an empty uterus, the size of which is altogether disproportioned to the magnitude of the abdominal tumor.

Extra-uterine pregnancy may be confounded with pelvic cellulitis, hæmatocele, fibroid tumors, and other tumors of the uterus.

Pelvic cellulitis.—I once committed the error of confounding a case of extra-uterine pregnancy with this affection. The points of resemblance between extra-uterine foetation and pelvic cellulitis are tenderness at the dome of the vagina, sometimes paroxysmal pain, an induration often more or less circumscribed, and a certain degree of uterine fixation. The points of dissimilarity are the conviction of the patient that she is pregnant, the extraor-

dinary pain, the violent constitutional manifestations, and the discharge of blood from the womb, phenomena which belong to extra-uterine pregnancy.

Pelvic hæmatocele is not necessarily associated with a previous history of pregnancy, is a diffused tense swelling, and either forms an enlargement on all sides of the uterus, if of the peritoneal variety, or, when infra-peritoneal, compresses the rectum and the bladder, none of which symptoms attend extra-uterine pregnancy.

Uterine, or ovarian tumors.—Meadows, of London, once opened the abdomen in a woman having a tumor supposed to be an abnormal pregnancy, but which turned out to be a fibroma. Tumors within the pelvis, whether connected with the uterus or with the ovaries, are not marked by any acute or violent symptoms, such as have been described as belonging to the initial stage of extra-uterine foetation, and, except when within the cavity or walls, are not accompanied by any increase in the depth of the uterine cavity, or by any of those changes of the os or cervix, as softness or sponginess, which mark pregnancy.

In uterine fibromata there is also an absence of independent movement between the organ and the growth, as change in the position of the one necessarily affects the other. Fibroids, again, are hard and generally irregular tumors. As the above characteristics are unlike any which belong to extra-uterine pregnancy, it is not probable that a mistake will be made by confounding the latter with the former, where the usual care is bestowed in the investigation.

Aside from other signs, fluctuation and the aspirating trocar will establish the distinction between abnormal pregnancy and ovarian and other cysts connected with the appendages of the uterus. A malignant growth within the abdomen has been mistaken for an extra-uterine foetation. Here, again, the early history of the latter must be recalled,—in every way unlike that of carcinoma, which generally progresses slowly, is attended with disorders of the digestive apparatus, is accompanied by a loss of flesh, and finally impresses on the face of the patient the lineaments of an unmistakable cachexia.

TREATMENT.—When an extra-uterine foetation has been early discovered, it has been proposed to destroy the ovum, either indirectly through the system of the mother, or directly, by acting immediately on the cyst.

The administration of ergot and of strychnia, and profuse bleedings, have been suggested with the first object in view, but do not merit serious consideration.

The second method has been attempted in different ways. *First*, the sac has been punctured through the vagina and the amniotic fluid drawn off. The operation, however, has been very unsuccessful. Sir James Simpson practiced it in one instance, but lost his patient. A similar result followed a like operation in my own hands. It has been repeated six or seven times, and always with a fatal termination, except in a single case,—that of Greenhalgh. *Second*, the sac has been opened by Professor Thomas through the vagina, by the galvano-cautery, and the embryo extracted. *Third*, attempts have been made to destroy the foetus by electricity. Dr. Jonathan Allen succeeded in two instances in accomplishing this by electro-magnetism, one pole being placed on the swelling in the vagina and the other over the hypogastrium.

Other methods have been proposed, but with so little prospect of effecting any good result that they need not be rehearsed. It is proper to notice, before leaving this subject, the proposition of Joulin, to destroy the embryo by injections into the sac, and which, in the hands of Koeberle, proved successful in one case. The agent which he used was the hydrochlorate of morphia.

The results of the different operations on the sac, made with the view of destroying the foetus, are not encouraging. Most of these procedures have been fatal to the mother, which alone is a sufficient reason for their con-

demnation. The fœtus, if allowed to remain quiescent in the sac, may arrive at a viable age, or may undergo those chemical transformations which transmute its tissues into a harmless mass of adipocere, or into some cretaceous substance.

Removal of the Fœtus per Vaginam.—In 1756, Dr. Charles Kelly suggested the extraction of the products of an extra-uterine conception by making an opening through the vagina into Douglas's cul-de sac, much in the same manner as is done in vaginal ovariectomy. This operation is not a difficult one, but should be confined to cases in which the fœtus can be clearly recognized as pressing into the vagina at a viable age, or after its death.

OPERATION.—The rectum and bladder being emptied, the woman, previously etherized, is to be placed on her back, with the hips projecting over the side of the bed, and with the limbs separated and flexed on the abdomen, each being supported by an assistant. The vagina is now to be expanded by a Sims speculum or by retractors, and the neck of the uterus seized and drawn downward and forward by a hook. The operator then makes a transverse incision through the vagina behind the cervix uteri, and through this incision the finger or a blunt hook is to be passed, and the fœtus extracted. Should the head present, it can be grasped by a small pair of obstetric forceps and delivered.

Placenta.—The important question connected with all operations for the removal of extra-uterine fœtuses is the proper management of the placenta; and obstetricians are not in accord on this subject.

Its detachment from a surface which has no muscular power of contraction, and which therefore is without power to close the sinuses or vessels, necessarily exposes the woman to the risk of hemorrhage; and death has followed in several instances from this cause.

On the other hand, the risk of septic poisoning must be considerable when a putrid mass like the placenta is allowed to remain. In a case upon which I operated, the organ was taken away, and no hemorrhage followed its extraction. Parry has published an analysis of 52 cases. Of this number the placenta was wholly or in part removed 24 times, with 12 deaths and 12 recoveries, or a mortality of 50 per cent. In 28 cases where it was permitted to remain, there were 10 deaths,—a death-rate of 35.71 per cent. The comparison consequently gives a percentage of 15.29 in favor of allowing the placenta to remain; and this is in accord with the opinion of a majority of the best authorities on the subject. Whether the operation is performed through the vagina or through the abdomen, the cord is to be brought out of the external wound, eight or ten days being required for the disengagement of the placenta.

In a case under the care of Dr. Elwood Wilson, in which the fœtus had reached maturity, I was able, without difficulty, to remove a dead child by opening Douglas's cul-de-sac through the vagina. Unfortunately, the sac in this case communicated with the peritoneum, in consequence of which the injection used to wash out the sac passed into the cavity of that membrane and destroyed the patient.

The merits of this operation have not been fully determined. Parry has collected 15 cases, of which 9 mothers died and 6 recovered,—a mortality of 60 per cent.; 2 out of the 15 children only were saved. I cannot, however, avoid believing that when the fœtus distinctly presents itself in the vagina, this operation should be preferred to any other.

Abdominal Section—Laparotomy, or Gastrotomy.—In removing the extra-uterine fœtus by this method, the incision is to be made in the median line of the abdomen, between the umbilicus and the pubes, with the same methodical division of the parietes as in ovariectomy. The sac is to be opened, the fœtus extracted, and if the cyst-wall is not already adherent to the abdominal

walls it is to be stitched to the latter, a drainage-tube introduced, and the external wound not closed to its full extent, but allowed to close by granulation, during which the sac is to be washed out with antiseptic solutions, as that of permanganate of potash or very dilute Monsel's solution of iron,—one part of the iron to twenty parts of water.

The mortality attending gastrotomy is influenced much by the previous existence or non-existence of adhesions between the cyst and the abdominal walls. In a collection of 62 gastrotomies,* 30 recovered and 32 died,—a death-rate of 51.61 per cent. The subject of adhesions is noticed in 24 cases. In 17 such adhesions existed, and in 7 they were absent. Of those in which adhesions were present, 11 recovered and 6 died,—a death-rate of 35.29 per cent.; and of those in which they were absent, 3 recovered and 4 died,—a mortality of 57.14 per cent.

The earliest operation of gastrotomy for the removal of the product of extra-uterine foetation, according to Parry, was made by Primerose, in the year 1594, the patient having, three years previously, expelled an extra-uterine foetus through the abdominal walls by the combined agency of ulceration and artificial enlargement of the opening. In 1714 a second operation was done in France, by Culvo, and a third in this country, in New York, by Dr. Baird. The second and third operations of this kind done in this country were by Dr. Baynham, the first in 1791, on the wife of a Virginia planter, and the second in 1799, on a negro slave, both proving successful. Not until 1823 was the operation again performed, when it was done by Dr. Wishart; and in 1846 a sixth gastrotomy for extra-uterine foetation was executed by Dr. Stevens, of New York City.

In Philadelphia, the extraction of the products of an extra-uterine pregnancy has been done by W. F. Atlee, Goodell, and myself.

Rupture of the Sac.—When an accident of this nature takes place, which is indicated by a feeling on the part of the woman that something internal has broken, immediately followed by severe pain, a pale countenance, nausea, a cold perspiration, and faintings, all of which are the ordinary signs of internal hemorrhage, there remains no hope for the patient except in an immediate resort to gastrotomy, and, after extracting the foetus, tying or closing by the cautery any vessels that continue to bleed.

Several interesting questions arise with regard to the propriety of operative interference in cases of extra-uterine foetation. It appears that the mortality following operations amounts to 51.61 per cent., while in the cases left to the natural processes of elimination the mortality is 52.65 per cent., leaving only one per cent. in favor of the operation.

What is the proper time to operate? Should it be done in case of rupture of the sac? or, this danger escaped, at any period when the delivery of a viable child is possible, for example, between the seventh and ninth months? and, finally, what course is proper after the period of maturity is passed?

In answer to the inquiry as to what course is proper in the event of rupture of the sac, it may be said that it has been shown that without surgical interference the accident is uniformly fatal, and consequently laparotomy holds out the only gleam of hope for the mother. As this accident generally happens before or about the fourth month, of course the preservation of the life of the foetus does not enter into the calculation.

When the danger of rupture is passed and the child reaches that stage of maturity which admits of its being extracted alive, what is the duty of the surgeon? Of 20 women operated on within the limits indicated, 14 died,—a mortality of 70 per cent., or a death-rate of 17.39 per cent. greater, so far as the mother is concerned, than when the case is left without interference.

Again, what is the duty of the practitioner when the period of maturity is passed, or when the foetus has perished? Under these circumstances it is deemed best by very competent authorities to withhold active interference

* Parry on Extra-Uterine Pregnancy, p. 242.

and wait for nature to make some sign. The irritation which is likely to develop in the cyst may be instrumental in uniting the sac to the abdominal walls, in which event the success of an operation, should it become necessary, is enhanced to the extent of about 22 per cent. Or an effort may in the mean time be made by nature to expel the fœtus by ulceration, in which process the chances of recovery are almost as great as by operation. It is also within the range of probability that through a retrograde metamorphosis the cyst and its contents may be transformed into some harmless substance and become quiet.

If none of these terminations occur, and the life of the mother is threatened as a result of local and constitutional irritation, there can be no objection to surgical interference, particularly after the woman has recovered from the perturbation incident to the puerperal state.

Lastly, when fistulæ have formed and portions of the fœtus are being discharged, shall the surgeon quietly look on, or shall he aid the process by the resources of his art,—that is, by enlarging the openings and extracting presenting portions of the child? Certainly he should adopt the latter course; though in making such enlargements he must be sparing in his incisions, for fear of transcending the limits of adhesion between the cyst and the part to which it is attached.

The introduction of Listerism into abdominal surgery will no doubt in time render necessary some modification of the above formulæ.

Rupture of the Uterus.

Rupture of the uterus is an accident of a very serious nature. It is produced by the power of its own contractions, by the rude use of instruments, or in consequence of violence applied to the walls of the abdomen.

If, during labor, after a pain of extraordinary severity there follow a sudden calm, a flattening of the abdomen, a progressive pallor of the face, a clammy perspiration, accompanied by a feeble pulse, cold extremities, and extreme exhaustion, the accoucheur has good reason to suspect a laceration of the womb. And when with these symptoms the uterus is empty, or the child has only partially escaped from it, the diagnosis becomes certain.

TREATMENT.—After the occurrence of such an accident there is no time for temporizing or delay. Unless the physician interferes for her rescue at once, the patient must soon perish from hemorrhage and shock.

If the fœtus has not entirely passed through the rent, the presenting part must be seized and the child brought away through the vagina, either by traction with the hands, or, in case the head remains in the organ, by instrumental means.

When the fœtus has passed wholly into the abdomen of the mother, the only hope for the mother is in the Cæsarean section. The operation has been twice successfully performed in Philadelphia, once by the late Dr. William Byrd Page and once by the late Professor John Neill. Both mothers were saved, but not the children.

In 40 cases of laceration of the uterus during labor, reported by Dr. Harris, 21 of the mothers recovered, 2 children were extracted alive, and 38 dead.

CHAPTER XXV.

SURGICAL AFFECTIONS OF THE SPINAL OR DORSAL REGION —MALFORMATIONS OF THE HEAD FROM EFFUSION.

UNDER this head will be considered the surgical diseases of the soft parts overlying the spine, diseases of the vertebræ, and diseases of the spinal marrow and its membranes.

Diseases of the Soft Parts.

Inflammatory peculiarities.—The integuments overlying the spinal region are remarkable for their density, compactness, and elasticity, in these respects resembling the scalp. Hence inflammatory attacks of the skin are prone to be of an erysipelatous or phlegmonous character. For the same anatomical reasons the back is often the seat of carbuncular attacks, especially the cervical part of the spinal region, where the skin is thickest.

Wounds.—Wounds attended with even a trifling loss of substance rarely unite by quick union. Traction is not well tolerated, and if attempted develops inflammation, and the sutures quickly cut through, permitting the parts to gape, and leaving a chasm to be filled by granulation tissue.

The arteries which are distributed in the soft parts of the back are not large, and consequently wounds of this region of the body are rarely followed by any considerable hemorrhage. The veins are remarkable for their size and the tortuous disposition of their trunks.

Blood tumors.—Blood tumors, the result of contusions, are very common, and often attain a large size. In most instances they disappear spontaneously by absorption, demanding only the local application of a compress wet with alcohol or a solution of muriate of ammonia and retained by firm pressure, made either by a broad bandage or by adhesive plaster.

Eruptions.—Eruptions over the dorsal region, especially if syphilitic, usually yield more reluctantly to treatment than those located on other parts of the body.

Furuncles.—The rich supply of cutaneous glands over the spinal integument favors the production of furunculous inflammation, though it will be found that in such cases there is never a large amount of pus as compared with the necrosed cellular tissue. The treatment of furuncle will not differ from that proper to boils elsewhere.

Abscesses.—The abscesses which appear in this region are oftener deep than superficial, and are always suggestive of disease of the bony structure of the vertebræ. Abscesses having such an origin reveal their true source by their course, shape, and location. The anatomical student will have observed that the erector spinæ muscles which lie on either side of the spinal column, filling up the vertebral grooves, are bound in position at the loins by a powerful aponeurosis, which also gives attachment to the vertebral extremities of the broad abdominal muscles. This aponeurosis arises by three leaves, one from the spinous processes of the lumbar vertebræ, one from the transverse processes, and the third from the bodies of the vertebræ at the root of the transverse processes. Between the spinous and transverse layers lie the erector spinæ muscles, and between the transverse and anterior layers the quadratus lumborum muscles.

Over the dorsal division of the vertebræ this aponeurosis is much less powerful, and is lost with the connective tissue on the sides of the trunk,

being covered by the broad muscles of the back, which are inserted on the scapula and the humerus. The surgical importance of this disposition of structure is as follows. *First*, an abscess in the upper portion of the spinal region proceeding from dead bone may be compelled to follow the course of the erector spinae muscles, and open very much lower down than the source from which it originates. Thus, a fistulous orifice which appears in the lumbar region may be traced upward to the neck. *Second*, a collection of pus, owing to the agency of gravity, and to the external and internal limitations of this lumbar fascia, will assume an oblong form, its major axis being parallel with the spinal column. *Third*, an abscess which is connected with disease of the lumbar vertebrae rarely opens on the surface of the loins, the strength of the aponeurosis in this region preventing such a course, and hence the accumulation, following the middle leaf of the fascia, advances forward between the abdominal muscles, and appears in one or other of the iliac regions at some point above Poupart's ligament.

All incisions which are made over the posterior part of the body for the removal of morbid growths should have a direction parallel with the course of the muscles; that is, parallel with the course of the spine when the structures to be divided are near that column, and oblique with it when the knife is applied over the latissimus dorsi or trapezius muscle.

The loose attachment of these broad muscles of the back makes it necessary to compress firmly a wound which has gone deeper than the muscles; otherwise, in the movements of inspiration, hemorrhage may be brought on, and a large collection of blood may find its way over the walls of the chest beneath the muscles.

Tumors.—*Adipose tumors* are the most common of all morbid growths in this region of the body, and attain in some instances a very great bulk. An

FIG. 1519.



Lipoma of the back.

aged German woman entered my office on one occasion, having what I supposed to be a peddler's pack strapped across her shoulders. Upon removing the clothing, she exposed an enormous lipoma suspended in a bag, and on withdrawing the support of the latter, the tumor, attached to the lower part of the neck, hung down almost to the loins. (Fig. 1519.) Its great weight had elongated the attachment of the mass into a pedicle, giving it a pyriform figure.

The friction to which the integument at the line of the cervical and cervico-dorsal regions—the most common seats of these tumors—is exposed from the weight of the clothing has much to do with the development of adipose growths. I have noticed them to be frequent upon the neck and shoulders of farmers at the points where the weight of the grain-bag used in sowing had been habitually supported.

Adipose tumors in the region under consideration are rarely found free or very movable, nor are they ever encapsulated in a loose layer of connective tissue, as occurs in other portions of the body. The fat, also, which composes the neoplasm is in coarse granules instead of being in lobular masses. These peculiarities render their removal

always somewhat difficult, as a tedious dissection has to be substituted for enucleation with the fingers.

Excision is the remedy for fatty tumors of the neck.

Sarcoma of the back is not common. The disease occasionally develops in the cicatrix or bed from which an adipose growth has been excised. I removed on three different occasions a round-celled sarcoma from the back of a prominent physician of Lancaster City, which started originally in the place from which a fatty tumor had been previously excised. At each successive reappearance of the tumor the growth occurred lower down, so that the disease, which was at first situated on a line with the lower angle of the scapula, finally occupied the lumbar region, the parts above remaining sound. It would seem that the elements of the neoplasm were influenced by gravity. The hemorrhage at each operation was considerable. The patient, after the lapse of two years, succumbed to the disease.

Fibroma.—Fibrous tumors are also among the morbid affections of the back. Their distinguishing physical characteristics are firmness of structure, fixedness of position, depth of situation, and a dull, heavy pain; their growth is slow. They originate in the connective tissue which underlies the muscles of the back. Only when the tumor exhibits a steady tendency to grow is it necessary to interfere, in which case excision will be proper. Small pendulous tumors, consisting of skin and connective tissue attached by narrow pedicles, are often found upon the back, and, as they are liable to become irritated by the clothing, may be clipped off.

Angeiomata, or *naevi*, are frequently witnessed on the back. The venous element, I think, generally preponderates, and they almost always extend down to the aponeurosis or muscles over which they are placed. Their growth is often very rapid. I removed, successfully, in a child, a patient of Dr. Wickoff's, of Princeton, a *naevus* from this region, which in a single year had become five inches long, two inches broad, and projected from the surface in a great, blue, spongy roll half an inch in height.

Naevi can easily be distinguished by the red color or the blue tint discoverable through the skin; by their soft, spongy feel; by the facility with which they can be emptied of their blood by compression; and by the readiness with which they become distended under the excitement of crying.

The treatment consists in removing the diseased mass either by excision or by ligature. (See *Angeioma*, vol. i. page 506.)

Sebaceous tumors.—Though the sebaceous glands are very abundantly distributed over the back, the sebaceous tumor or cyst cannot be regarded as common in this region. It is known by its rotundity, slight elasticity, and tardy growth, and by a minute dark point visible in the centre and marking the position of the remains of the excretory duct. Subjected to the friction of clothing, sebaceous tumors sometimes become tender, inflamed, and suppurating; in such event they should be laid open, the contents turned out, and the sac removed.

Epithelioma.—Some of the most extensive examples of epithelioma are met with in the back. I saw, with Dr. Levis, of this city, an ulcer of this character along the side of the spine which was not less than seven inches in its smallest diameter. The edges of the sore were irregular and everted, its sides shelving, and the discharge ichorous, exceedingly copious, and offensive.

Early removal with zinc paste, caustic potash, or the knife, and filling the chasm by transplanting a flap of sound integument, constitute the proper treatment.

Encephaloid and melanotic cancers of the back present all the characteristics of these formidable affections elsewhere, namely, elasticity, irregularity of surface, and rapid growth. The most that can be claimed for an operation is palliation. Too often the knife imparts an additional momentum to the disease, and hastens an event which a more conservative course would have delayed.

The melanotic variety can be distinguished by its dark color, superficial

position, resistance to pressure, and knotty surface. Males more commonly suffer from melanotic disease.

Several tumors of the kind may exist at the same time, none of which attain any great size, the disease being remarkable for its tendency to multiplication rather than for the bulkiness of the neoplasms.

Congenital tumors at the lower extremity of the spine are not uncommon. They are situated usually over the sacrum or the coccyx, and, occupying as they do the median line, their diagnosis is not a little embarrassing. These growths are cystic, fatty, sebaceous, and dermoid.

Cystic tumors.—These, coming out as they do sometimes between the arches of the vertebræ, I am disposed to believe are in many instances hydrorachitic in their nature, the neck of the sac having undergone a spontaneous closure, but the lining membrane of the tumor continuing to secrete and the cyst to grow. So far as the composition of their contents is concerned, it does not differ from the fluid found in hydrorachis. As it is impossible always to distinguish these cysts from those in spina bifida, it will be necessary, when the removal is decided upon, to make a careful dissection of the elliptical flaps which are taken from the base of the tumor, until the true relations of the neck of the sac are ascertained, when, if traced to the theca of the cord, and not through its membrane, removal will be proper. If, on the other hand, a communication exists between the tumor and the arachnoid or subarachnoid space, it will be better to replace the flaps, and, after recovery from the operation, to proceed as in a case of hydrorachis.

Fatty tumors over the sacral region are lobulated, with hard, deep constrictions between the lobules. They are sometimes globular, but more commonly conical and twisted. They may start within the spinal canal, as happened in the cases recorded by Mr. Athol Johnson and by Mr. Pollock.* Should they cease to enlarge, they may be safely left alone, as it is not improbable that after a certain period they will diminish and shrivel up, leaving only a tag of corrugated integument. If, however, the growth continues to increase, it should be excised.

Dermoid tumors.—The sacral region is a favorite locality for the development of cysts which contain teeth, hair, etc. The *sebaceous* cyst is probably of this nature. These tumors may be attached to the sacrum, or their attachment may exist within the pelvis, the tumor coming out between the sacrum and the coccyx.

Fœtal tumors.—Numerous examples of tumors containing fœtal remains, as cartilage, bone, etc., are recorded by medical authors, as are also cases in which a part of another child, as a leg, has grown from the sacrum, or in which a tumor, similarly attached, has contained a portion of the intestine.

The treatment, in such monstrous developments, is removal by the knife or by the ligature, when there is reason to believe that the tumor does not communicate with the spinal marrow or with some important organ.

Bursal tumors.—Immediately over the vertebra prominens is placed a large bursal sac, which, under the weight of a heavy overcoat or other clothing, is liable to become inflamed and cause considerable suffering.

The nature of the swelling will be disclosed by its situation at the junction of the cervical and dorsal regions of the spine, and by its tenderness to pressure. All pressure must be taken off this part of the neck. To effect this I have frequently employed a pad stuffed with cotton, having an opening in the centre to receive the enlargement, and held in position by being stitched to the under-clothing. At night the application of a lotion of lead-water and laudanum will give great relief. I have never been compelled to resort to any more radical measures.

Sprains of the Spine are accidents to which quarrymen, carpenters, and railroad operatives are peculiarly liable. When of a severe character the spinal marrow may participate in the injury. If the force is applied directly,

* Transactions of the London Pathological Society, vol. viii.

there follows, of necessity, more or less contusion of all the soft parts, including the muscles; but even when the force is indirect, the latter do not escape. They are injured either in the extraordinary efforts which are made by the subject of the accident to save himself from the impending danger, or, taken by surprise, their fibres may be torn, or their tendons be displaced. The swelling, which quickly succeeds violence, is caused by the laceration of vessels, chiefly veins; and in severe cases the disordered sensibility and loss of motion imply that either the spinal nerves before or after they emerge from the intervertebral foramina, or possibly the spinal cord, or both, have sustained some harm, most likely from the pressure of blood. Hæmaturia sometimes follows severe injuries of the lumbar spine, but I can recall no case where renal hemorrhage was present unless the force producing the accident was direct. Indeed, it is highly improbable that mere flexion or extension independent of direct violence could affect the kidneys to a degree sufficient to produce such a result.

Hæmaturia may follow a sprain of the loins which is brought about by voluntary muscular efforts, as in raising some body of great weight; but here there is an element introduced which is absent in ordinary accidental sprains, namely, the forcible pressure of the viscera by the abdominal muscles against the emulgent veins so as to cause congestion and rupture of some of the renal vessels.

DIAGNOSIS.—A spinal sprain followed by great helplessness and some degree of paralysis may simulate fracture of the vertebræ. In the latter, however, the disability is complete. The patient lies on his back, unable to turn upon the side, or even to remain there when so placed, as he can in sprain. Besides, in sprain the tenderness is more diffused than in fracture, nor is there ever any irregularity in the line of the spinous processes. Paralysis is a uniform accompaniment of fracture, but not of sprain, and when present in the latter it is much less pronounced than in fracture, and soon disappears.

TREATMENT.—Taking any of the cases which have been cited as a type of spinal strain, the treatment proper to be adopted will be, in case the injury has been received in the cervical region, to place the patient on the back, with the head and neck resting on a soft pillow and supported on each side by a short bag of sand. Blood should be drawn from the part by cups or by leeches, and over the entire back of the neck, followed by the application of lead-water and laudanum. In a few days, or after the first effects of the injury have passed off, great comfort will be experienced from imbedding the posterior part of the neck in a flaxseed-meal poultice, which can be kept moist and warm by placing over it a piece of oiled silk or rubber-cloth. Rest is to be procured by the bromide of potassium, or by some preparation of opium. The bowels should be moved once every two or three days, and the diet for the first three or four days must be restricted and simple.

When the sprain is in the lumbar or sacro-lumbar region, the dorsal position is not the most comfortable; the patient will usually seek that on the side.

After the acute symptoms have subsided, there will remain a considerable degree of soreness and stiffness, aggravated always by the patient attempting either to sit or to stand, and which is seldom got rid of under ten or twelve weeks. During this period the best applications are stimulating lotions, as soap liniment mixed with oil of amber, or tincture of aconite and chloroform, aided by judicious "massage."

It is best, particularly when the sprain is in the loins, not to insist on the erect position before the disappearance of much of the soreness.

When the patient begins to leave his bed, great assistance will be derived from the use of a plaster bandage applied about the hips and loins. An artificial support of this kind will enable the person to sit or to walk without exacting too much from the enfeebled muscles of the spine. This bandage must not be worn too long, otherwise the muscles will waste. Accordingly, after three or four weeks it should be laid aside.

Spinal Myalgia.

In this place may be appropriately considered a very common affection of both the lumbar and the cervical region, characterized by a sudden and severe pain in the muscles of the loins or of the neck, and which occurs while stooping down, or while twisting the body, or sometimes in the act of drawing on a boot. It is described under different names, as lumbago, "crick," myalgia, etc. It rarely lasts more than three or four days, and occasionally disappears as suddenly as it came. In many cases the attack is undoubtedly rheumatic, but in others it is due to the displacement of a muscular fasciculus, the sheath of which has given way, or to a similar dislocation of one of the numerous small tendons belonging to the muscles of the spine.

The differential diagnosis between the spinal myalgia resulting from rheumatic causes and that arising from muscular displacement may be approximately established by the following considerations:

In the former, motion in almost any direction is attended with suffering, and the soreness and tenderness are diffused; in muscular displacement the distress or pain will be local, and confined to some single movement. Besides, a careful inspection of the surface will sometimes reveal a small dimple or depression, or possibly a little bulging, either of which marks the seat of the displacement.

TREATMENT.—Rheumatic spinal myalgia requires cupping over the affected region, followed by stimulating frictions and full doses of quinine. Rest, which naturally falls in with the feelings of the patient, is not always desirable. The disease will often disappear more quickly if moderate exercise is taken.

Should the pain linger beyond three or four days, showing no disposition to leave, the cure will be hastened by the internal administration of iodide of potassium with wine of colchicum. Beating the muscles gently with a gum ball attached to an elastic rod, until the surface becomes red, will often prove a valuable adjunct to the treatment.

When there is reason to believe that the pain is due to muscular or tendinous dislocation, the remedy is reduction. To accomplish this, let the patient first assume the posture which causes the severest pain, and then let him change the position to one exactly opposite, when the surgeon thrusts the fingers into the seat of pain, pressing the parts away from the side towards which the body of the patient is inclined, and directing him at the same time to resume a natural posture. If there has been no error in the diagnosis, the manipulation will most likely be followed by an instantaneous relief from pain.

Injuries of the Spinal Cord.

The relation which the spinal cord sustains to the spinal canal, resembling, in many respects, that which subsists between the brain and the cranium, naturally suggests a similar classification of its injuries and diseases. Thus, we have the so-called concussion and compression of the medulla spinalis, equivalents of concussion and compression of the brain.

Concussion.—When it is considered that the medulla spinalis is closely embraced by its pia mater, that it does not fill the spinal canal, that its connections with the latter are only at points where the nerves pass through the intervertebral foramina, that it is surrounded by a stratum of fluid, and that in the structure of the vertebræ and their connections everything conspires to neutralize vibrations, it is impossible to believe that concussion of the cord can be a very frequent accident. Indeed, I am at a loss to know, either from clinical experience or from the revelations of the dead-house, what phenomena disclose uncomplicated concussion of the spinal cord. Cases

of death have been reported from spinal concussion, as they have been from cerebral concussion, in which it is said that no lesions whatever could be discovered. But too often the examinations did not extend beyond the spinal canal, and are, therefore, not entitled to be accepted as final or conclusive in establishing the truth of the statements. The effects of violent injuries of the spine, both direct and indirect, are not necessarily limited to the cord, but extend to the head and to the viscera, abdominal and thoracic; and in these instances of death without discoverable lesions it is probable that, unless life had been extinguished by shock, some of these cavities, had they been searched, would have surrendered the secret.

The symptoms which are said to indicate concussion of the spinal cord—and by the term is meant a jar or shock which affects primarily the substance of the medulla spinalis within its membranes, independent of any lesion of the spinal column—may follow force applied either directly or indirectly. An individual falls from a height upon the buttocks; the violence is transmitted to the spine; it is followed by numbness, tingling, loss of power in the lower extremities, pallor of the face, and sickness of stomach, with probably vomiting. The symptoms are represented as the expression of a concussed spinal cord; but every one may be present without the latter having realized a single vibration from the blow. The sacral nerves have probably received the brunt of the injury, and have given rise to the disturbances of sensation and motion; and the shock sustained by the ganglionic masses of neurine within the abdomen, which lie immediately in contact with the spine, would be quite sufficient to account for the gastric disturbance.

Again, a blow applied to the cervical region of the spine may be followed by spasmodic contraction of certain muscles of the neck, or by temporary paralysis of an arm, by hiccough, or by a cord-like constriction of the body, yet all these phenomena are quite intelligible without assuming the existence of concussion of the cord, as the nerves concerned in producing these different symptoms are all within the reach of contusion from the vulnerating body; and the symptoms are usually of temporary duration, indicating a peripheral rather than a central causation.

A concentrated force delivered upon the lumbar spine is also said, in consequence of concussion of the cord, to induce paralysis, motor, sensory, or both, of the lower extremities, with a similar loss of power in the bladder and the rectum. But what proof have we that such effects are not the results of compression of the cord from rupture of vessels within the spinal canal rather than of concussion? Until there is evidence more conclusive than any at present possessed, I must remain skeptical in regard to the existence of spinal concussion as a sufficient cause for many of these phenomena.

Mr. Erichsen has described a variety of spinal concussion arising from indirect violence, which he believes to be peculiar to the shock incident to railroad collisions, independent of any detectable wound, bruise, or other external injury, and characterized by secondary phenomena, both physical and mental, which are referable to an insidious chronic inflammation of the cord and its membranes.

After an accident of the above character, a person who, by the sudden arrest of a car in rapid motion, is thrown violently forward, then rebounds in the opposite direction, or, it may be, falls with a severe twist, soon recovers from the confusion and shock attending the accident, with no abnormal feelings other than a little soreness or stiffness from having been shaken up, and perhaps a little tremor and faintness from the fright and excitement of the moment. Nay, more, he may be able to participate in the efforts made to rescue others from the wreck and give such other aid and relief as the unfortunate sufferers may require. Some time following, it may be almost immediately, or after several months, he becomes conscious that something has happened. A change, visible even to his friends and acquaintances, is noticed, though so undefined that it is difficult to say exactly in what it consists. His

accustomed energy and interest in business begin to lessen; he finds himself unequal to the ordinary exactions of his calling; the memory fails in many particulars; there is more or less confusion of thought, an incapacity for mental concentration, an inability to sleep, or his slumbers broken by horrid dreams. Noted hitherto, perhaps, for calmness and amiability, he becomes impatient, fretful, and capricious. The organs of special sense are disturbed. The vision is defective, in consequence of which objects are seen double or confused; flashes of light and floating specks frequently annoy him, and, in some cases, even strabismus is present. The hearing may be obtuse or over-acute, and noises strike painfully upon the ears. The sense of touch is modified, the patient, as in ataxic disease, being unable to seize small objects like pins, or to button his shirt or vest. The speech is sometimes altered, sentences being spoken with hesitation, or perhaps with stammering. In addition to these symptoms there is a peculiarity in the gait and in the attitude of the patient, indicated by the straddling, shuffling, and unsteady use of his limbs, and by the stiff, mechanical manner which is assumed in standing. In order to walk safely, he finds it necessary to fix his eyes steadily on some object in advance. Motion and sensation in the limbs differ in different cases. Sometimes both motor and sensory paralysis are present, affecting alike the upper and the lower extremities; at other times one leg and one arm, it may be on opposite sides of the body, are involved; in addition to which, various eccentric sensations are experienced, as pricking, tingling, burning, crawling, etc. The nutrition, moreover, suffers; the muscles become soft and waste; a slow and general emaciation may be observed; the strength continues to diminish, the paralysis becomes more pronounced, and the individual dies after an illness varying from a few months to several years. Such is a brief *résumé* of the phenomena which are said to characterize the spinal concussion resulting from railroad collisions.

Dr. Lockhart Clarke,* in one instance, examined the spinal cord and brain of a man who died between three and four years after receiving a severe concussion in a railroad accident without any external marks of injury, and whose symptoms answered, in the main, to those which have been detailed. There were in this case the usual signs of both spinal meningitis and myelitis, with a remarkable diminution in the antero-posterior diameter of the cord, especially in its enlarged cervical portion, and also a singular limitation of disease to the posterior white columns, indicated only by the presence of numerous compound granular corpuscles and scattering granules, many of the nerve-fibres having been replaced by a wavy fibrous tissue. There was also a general opacity of the cranial arachnoid, with a serous effusion beneath that membrane, and the gray matter on the under surface of the anterior lobes of the brain was found somewhat softened.

It does not appear, however, that the initial change of structure in the extensive and varied assemblage of morbid phenomena which characterized the case was primarily located in the cord; nor has it been proven that similar structural alterations in the cord and brain may not as often follow spinal injuries from other than railroad collisions. In other words, it is not clear that there is anything peculiarly distinctive or original in the concussions received by persons who encounter injuries from the collision of railroad trains moving at a high rate of speed.

Wounds of the Spinal Cord are almost invariably fatal, the suddenness of the event being determined by the region involved, increasing as we ascend the cord, in consequence of the number of important parts paralyzed, until the cervical region above the origin of the phrenic nerves is reached, when death follows quickly.

The cord may suffer in different ways from a vulnerating cause. The lesion may consist in a punctured, incised, or gunshot wound, and often of a fracture of the spine, in which the substance of the cord is compressed by

* Transactions of the London Pathological Society, vol. xvii. p. 20.

hemorrhage or by a fragment or fragments of bone being driven into its substance and bruising, lacerating, or even entirely severing the cylinder of the medulla.

A boy was brought into the University Hospital who survived for twelve hours, notwithstanding a ball had entered between the bodies of two cervical vertebrae and passed through the spinal canal, cutting the cord, and emerging between the spinous processes. Fig. 1520 is a cut taken from this preparation.

The treatment will not materially differ from that proper to a case of fracture of the spine. The paralyzed soft parts should be protected as much as possible from the effects of pressure, and the bladder should be catheterized. In gunshot wounds attended with comminution of the vertebrae, it will be proper to pick away any loose fragments which may press on the cord; but attempts to relieve compression by the use of the trephine are as useless after gunshot wounds as after fractures. Inflammatory symptoms affecting either the cord or its meninges as an effect of wounds should be met by the local application of leeches, followed by ice and by alterative doses of mercury.



FIG. 1520.

Perforation of cervical vertebrae and of the cord.

Compression of the Spinal Cord.—Compression of the spinal cord is produced by traumatic and by inflammatory causes. The compressing material may be bone, blood, serum, lymph, or pus.

Compression from bone has been considered while treating of fractures and dislocations of the vertebrae, and need not be again referred to in this place.

Blood-pressure.—When the compressing agent is blood, there are three sources from which the hemorrhage may be derived: *first*, from the laceration of veins in the spinal canal, between the latter and the theca of the cord; *second*, from the vessels between the cord and its membranes; and, *third*, from the vessels contained in the substance of the medulla.

The first, namely, hemorrhage from the rachitic veins, I believe to be more common than is generally supposed. These vessels are thin-walled, large, and receive very little support from any surrounding tissue, and hence are liable to be ruptured by falls and blows, direct or indirect, upon the spine. The blood accumulates in the canal, gravitating towards its lower part, and encroaches upon the membranes and the medulla spinalis, as well as upon the vertebral part of the spinal nerves, exerting (Fig. 1521) sufficient compression in severe cases to suspend the functions of the cord, just as a similar clot within the cranium produces compression of the brain.

Hemorrhage derived from the vessels within the theca of the cord is rarely seen independent of fracture of the vertebrae; and the same is true with regard to that occurring within the substance of the medulla, unless, as stated by Charcot and Hayem, there has been a preceding myelitis, when it is likely to follow, laceration of the membranes being a common attendant in both.

When the blood which collects in the canal is in sufficient quantity to cause paralysis, it may be disposed of by the vessels, whether coagulated or not, and with the removal of the compressing material will likewise disappear the motor, sensory, or moto-sensory paralysis which may have been present.



FIG. 1521.

Clot of blood in the spinal canal from rupture of the spinal veins.

It is not possible to distinguish with certainty from what vessels the blood in a case of spinal hemorrhage comes. The following considerations furnish reasonable grounds for a diagnosis:

First. The space which exists between the cord and the walls of the spinal canal is so considerable that it will require some time (a few hours) after an injury before the accumulation will be large enough to make sufficient pressure on the medulla spinalis to develop paralysis. The latter is likely, from this very circumstance, to be gradual in its appearance. When, on the other hand, the blood issues from the vessels of the membranes, or from those in the substance of the cord, the compression will be sudden, immediate, and direct, and the paralysis instantaneous.

Second. When the hemorrhage comes from the veins of the canal, the substance of the cord is less exposed to injury and the symptoms of compression are more likely to disappear than when the blood is derived from either the vessels of the meninges or those of the spinal marrow. As in the former case, the extravasation is not in contact with the medulla spinalis, and the coagulum is more easily disposed of through the agencies of the veins and lymphatics.

Compression from lymph, serum, or pus has, necessarily, an inflammatory history,—a precedent meningitis or myelitis.

Meningitis may arise from contusion of the spinal nerves or of their sheaths as the former leave the intervertebral foramina; or the inflammation may be propagated to the meninges from carious vertebræ, as in Pott's disease of the spine, independent of any traumatic excitant. If the meningitis terminates in the transudation of serum, lymph, or pus, compression of the cord follows, and with it a certain degree of paralysis. The time at which the latter appears will depend on the chronicity of the meningeal inflammation,—seldom, perhaps, earlier than a week or later than six weeks.

It is possible to have symptoms of compression of the cord from pus without any antecedent disease of the meninges, as when the contents of an abscess in a diseased vertebra force their way into the spinal canal. In instances of this kind, however, there will have been a previous history of spinal osteitis, and the signs of compression, or the paralysis, will probably occur suddenly.

Myelitis.—A meningitis may become a myelitis, but the secondary condition is not likely to succeed the first very rapidly, requiring, perhaps, six or eight weeks. When, however, the inflammation at length invades the cord, the latter rarely escapes serious alterations in its structure. The morbid changes may be local or diffused, sometimes involving the white substance of the medulla spinalis, producing softening, and sometimes affecting the axis of the gray substance; while in other instances of chronic myelitis there is at the commencement of the disease a remarkable increase in the cell-forms of the neuroglia, and with this increase a corresponding wasting of the nerve-fibres. The resulting thickening or sclerosis affects usually the posterior column of the cord, and constitutes the degenerative characteristic of locomotor ataxia.

Those degenerations of the cord which succeed to traumatic violence are in a very large proportion of cases the result of disease propagated from without inward, and do not originate in the medulla spinalis. It is thus, I believe, that after violent wrenches, contusions, twisting, or straining of the spinal column, its ligaments and articulations, a slow, insidious inflammation, beginning in the sheaths of the nerves in the periosteum or in the connective tissue which lies in the irregularities of the vertebræ, creeps along these lines of conduction until the membranes of the cord are reached, and, finally, the cord itself, after which follow those tardy central degenerations of structure in which progressive paralysis plays so conspicuous a part, and which entail an invalidism worse than death itself.

Laceration of the meninges and of the cord is an accident almost peculiar to fractures and dislocations of the vertebræ, in which a displaced portion of

the broken or dislocated bone is driven into the spinal canal. The pia mater invests the cord so closely that it may be torn without the other membranes participating in the lesion. This accident is likely to follow extreme flexion of the spine, and when the membrane gives way the nerve-substance of the cord presses through the rent.

It will appear from the preceding remarks that paralysis as a result of traumatic violence has a broad pathological significance, and the question naturally arises, Is it possible, in every instance, to determine the nature of the producing cause?

In answering this question, it must be admitted that there is always some uncertainty in the diagnosis of spinal injuries, more, indeed, in regard to causation than in regard to lesion.

In endeavoring to establish the relation between spinal lesions and their usual causes, it will be necessary to ascertain the time at which the symptoms appear after the receipt of an injury, and their nature and severity. With regard to the question of time, we may formulate our knowledge as follows: 1. When the symptoms occur instantaneously after the reception of some violence communicated to the spine, the lesion is probably a central one, affecting the substance of the cord, and the cause is pressure from bone. 2. When the symptoms develop only after the lapse of several minutes or hours, the lesion is intraspinal, and the cause is pressure produced by rupture of blood-vessels situated either between the walls of the spinal canal and the membranes or within the latter and the cord, the delay in the paralysis being due to the fact that some time is required for the blood to accumulate in sufficient quantity to interfere with the functions of the cord. As to the particular vessels implicated in the injury, it may be affirmed that the more rapidly the symptoms of pressure appear the stronger will be the evidence that the hemorrhage comes from those within the membranes, as, when from this source, the extravasation has not the same room for diffusion as when the blood is derived from the veins of the spinal canal, and consequently the pressure is more concentrated. 3. When symptoms are delayed until after the lapse of six or seven days, or even perhaps one or two months, it is reasonable to refer them to inflammatory causes, pressure being due to serum, lymph, or pus,—the product of a meningitis or a myelitis, or of both.

Symptoms may be postponed for even eight or ten months after an injury; and when this is the case it is evidence of there having been an intermediate inflammation of an extremely chronic or negative character, which has caused serious, most likely incurable, degeneration of the cord.

The differentiation of the phenomena which are meningeal from those which are central or located in the cord is often difficult, many symptoms being common to both peripheral and central disease.

Pain in the spine, though more common in meningitis than in diseases of the cord, has not much diagnostic importance in the present connection, inasmuch as it has a wide range of causation, being present in diseases of the vertebræ, in rheumatism and neuralgia of the back, and in different disturbances of the digestive organs. More importance is to be attached to those pains which are uniformly experienced in certain parts supplied by the sensory nerves. These are believed to indicate a central rather than a peripheral irritation; and, although the seat of irritation may be located either in the cord or in the membranes at some point between where the nerves emerge from the medulla spinalis and where they leave the intervertebral foramina, yet as a means of separating those symptoms which in their origin are extraspinal from those which are intraspinal they possess great value.

There are, nevertheless, pains of a certain quality which are quite pathognomonic,—those, for example, which are darting, shooting, brief in their duration, like an electric flash, or those which convey the impression of constriction. These pains are often associated with certain modifications of sensation, as pricking, numbness, and a feeling as though some soft fabric, like

velvet, was being passed over the surface. These symptoms all point to serious degeneration of the cord. Muscular spasms occurring early after an injury of the spine indicate acute meningitis, as in this inflammation the reflex centres are preternaturally excited. When the spasms appear late in the progress of the case and are gradually developed, they are most probably dependent on disease of the lateral columns of the cord.

Again, changes in the nutrition of the muscles afford valuable information in regard to the seat of the lesion. The influence which administers to the nutrition of the muscles finds its way from the cord to those structures along the motor fibres or the anterior roots of the spinal nerves; and whatever interrupts the passage of the nerve-fluid along these paths of conduction is followed by the atrophy of the muscles or groups of muscles to which these nerves are distributed.

It is here that electricity comes to our aid. In the healthy condition of the motor nerves the application of either the faradic or the galvanic current excites contraction in the muscles supplied by their branches, continuous when the stimulus is faradic and intermittent when voltaic. If, therefore, on applying those tests, no movements can be excited in the paralyzed muscles and there is no evidence of the nerve-cord being compressed or severed, the legitimate deduction is that the lesion is central. It is possible, in some instances, to find the susceptibility to faradic stimulation lost, while the voltaic irritability is increased. This occurs in degeneration of the nerve-fibres.

The loss of certain reflexes, as that of the tendo patellæ, the ankle, and the cremaster, is regarded as strong evidence of central disease. These reflex movements are made as follows:

In the case of the patella reflex, if the leg is allowed to hang without restraint at right angles with the thigh, while the latter is supported either by the arm or across the opposite limb, and the tendon of the patella or of the quadriceps femoris is briskly tapped with the edge of the open hand, there follows an instantaneous contraction of the extensors, raising the leg. The ankle reflex is produced by placing the hand against the sole of the foot and flexing the latter on the tibia, while the leg is supported on the knee; a sudden contraction is experienced. When these movements cannot be elicited by the employment of the proper test, the failure is attributable to disease located in the cord.

Again, rigidity and spasmodic contraction of muscles, if accompanied by muscular atrophy, point to central rather than to meningeal disease.

Tumors.—Tumors of the spinal cord or of its membranes are rarely seen, and when met with are in most instances connected with the meninges. These neoplasms of the medulla spinalis and its membranes are fibrous or sarcomatous, and in the course of their growth give rise to symptoms of spinal irritation and paralysis.

Injuries of the Spinal Column.

Mechanism.—It is impossible properly to appreciate the diseases and injuries of the spinal column without a thorough understanding of the anatomical construction and the physiological function of this portion of the skeleton and of the part of the nervous system which it contains.

The vertebral column is a pillar of support, a centre about which all the movements of the body are executed. To it are attached the ribs and several of the muscles concerned in the mechanism of respiration; from it is suspended a considerable part of the digestive tract. In a canal which traverses its entire length are placed the medulla spinalis and its membranes; and from its sides emerge the nerves, which are distributed to the outstanding organs and confer motion and sensibility on the muscles of animal and organic life. Every shock communicated to the body must affect in some degree this axis of the osseous system and its contents. The neces-

sary requirements of flexibility, solidity, and support have been wonderfully produced in the spinal column by a complex association of diverse structures.

The osseous part, instead of consisting of a single cylindrical bone, is made up of a number of separate superimposed pieces, each having arches which inclose a central opening, these openings forming, when all approximated, the spinal canal. Between the bodies of the different vertebræ are interposed fibro-cartilaginous cushions, which serve the double purpose of binding the bones together and of breaking by their elasticity the vibrations which are communicated to the body. Between the laminae of the vertebral arches the spaces are filled by yellow elastic membranes (*ligamenta subflava*), which fulfil in this locality, but even more completely, the same requirements. Subjected as the spinal column must continually be to flexions and twists, both voluntary and involuntary, it is necessary that its individual parts should be securely bound together: this is accomplished by the seven processes, articular and non-articular, possessed by each piece, and which are so disposed and so locked together by powerful ligaments of white fibrous tissue that only a small degree of movement is allowed between any two pieces, although in the aggregate it is quite considerable.

It will be seen also that at those regions of the spinal column where the range of movements is greatest, as in the cervical and the lumbar, and where, in consequence, the spinal marrow would be most exposed to pressure, the canal is largest. To provide a safe way for the passage of the spinal nerves from the spinal marrow, each vertebra possesses a notch on the upper and lower surfaces of the pedicles at their junction with the body.

In addition to these marvelous adaptations of structure to function, there is developed in connection with the assumption of the erect position a series of curves. These not only conduce to grace of movement, but secure, on well-known mechanical principles, increased strength, with diminished expenditure of muscular power, and permit of the transmission of vibrations with gradually lessening momentum.

On opening the spinal canal of the cadaver it will be seen that the cord does not fill it, but is suspended in it, attached above at the foramen magnum occipitis, and below by the *filum terminale*, and that its connections or *guys*, laterally, are at the points where the nerves, encased in prolongations of the *theca*, pass out through the intervertebral foramina. Between the cord and the walls which inclose it lies a plexus of large, thin-walled veins, supported by loose bands of connective tissue and fat. The cord in the adult, moreover, when approaching the lower portion of the spinal canal, or at the last dorsal vertebra, loses its cylindrical form and is continued on through the lumbar and sacral regions—those portions greatly exposed to concussion—in the form of a leash of large, firm nerves, enveloped in the *theca* and other membranes of the structure.

We find, too, that between the *pia mater*, which closely embraces the cord, and the arachnoid membrane, a considerable space exists,—the *subarachnoid*,—which is occupied by fluid, thus furnishing the *medulla spinalis* the benefit of a hydrostatic support, in which it may be said to float. Filling up the grooves on either side of the spine, and between the transverse and spinous processes, are lodged muscles, with their numerous tendons.

It may be affirmed of all injuries of the spinal column (as of those of the cranium) that their danger must be measured by the damage done to the contents,—in this case, the *medulla spinalis*.

Sprain.—Considering the number of joints and ligaments possessed by the spine, with the violent twists and bends to which they are subjected, it is no matter of surprise that the column should be subject to sprains. Along with most of these injuries there is more or less muscular damage sustained, either by overstretching or by contusion. The portions of the spine which suffer most are the lumbar and the cervical,—parts possessing normally the greatest

degree of motion. The determining force may be applied either directly or indirectly.

A butcher, while bending over his block, was struck on the back of the neck by a quarter of beef, which fell from the hook on which it had been suspended. The momentum and weight of the vulnerating body bent the spine and head violently forward, but did not force him to the ground. The pain experienced through the muscles of the neck was very severe. He was unable to turn his head towards either side, and when desiring to look to the right or to the left was able to do so only by turning the whole body in the required direction, the head and neck being preserved in a perfectly immovable position. The parts in a few moments became swollen and intolerant of pressure. The power of the upper extremities was materially lessened, though sensation was but slightly if at all impaired. In a few days a marked induration could be felt deeply imbedded in the muscles on the back of the neck, the acute pain subsided into a deep-seated ache, deglutition became painful, the back of the scalp felt sore, and at night some heat of skin and restlessness indicated a slight febrile disturbance. Here was an instance of spinal strain attended with muscular contusion, caused by force directly applied.

A laborer descending a staircase lost his footing and fell, the back of the head striking against the wall at the foot of the landing, the resistance of which, opposed to the weight of the body, caused a severe flexion of the cervical spine. When help reached him, his head was found to be rigidly fixed. Any attempt to turn it to either side extorted a cry of suffering. The upper extremities were numb and weak, there was a tingling of the ends of the fingers, and the back of the neck was swollen and sore to pressure, becoming much ecchymosed. In the course of four or five days the man recovered the power and sensibility of the arms, but the muscular immobility and the dread of moving the neck were so great that, when he was asked to flex or extend the head, he would place one hand under the chin and the other upon the occiput, and thus cautiously make the movement. Any effort to turn the head to the right or to the left was preceded by placing a hand on each temple and then turning the body along with the head. These symptoms gradually passed away. The case was an example of spinal strain caused by violence indirectly applied.

A carpenter, while engaged at his work, was caught between the joists of a building and a falling scaffold. While held by the pelvis, the body was forcibly twisted by the weight of the superincumbent timber. When he was extricated from his perilous position, his lower limbs were found to be powerless and the sensibility almost entirely lost, the pain in the loins was severe, the muscles over the lumbar spine were tender and swollen, he was unable to turn himself in bed, and the urine dribbled from the bladder. In twelve days motion and sensibility returned to the limbs, the continence of the bladder was restored, and, except weakness and soreness in the muscles of the lumbar region, which made any attempt to rise or to sit extremely painful, the effects of the injury appeared to have passed away. Here was an example of spinal strain produced by the operation of indirect forces acting in opposite directions and twisting the spine. These sprains, then, are caused by flexion, by extension, and by twist.

The morbid changes which attend an accident of this nature consist in the overtension or the rupture of some fibres of the spinal ligaments. When determined by flexion, the ligaments involved are the supra-spinous and the posterior common vertebral. When the accident follows extension, the ligament implicated is the anterior common vertebral; when caused by twist, the articular ligaments and the vertebral fibro-cartilages suffer chiefly. In addition to the damage done to the ligaments, the muscles, blood-vessels, nerves, and synovial membranes participate in the injury.

Contusions of the muscles of the back, when severe, are followed by

stiffness and pain on sitting or standing, all movements of the body being painful.

Congenital Defects of the Spine, and their Consequences.

Arrest of development may occur in this region, as in other parts of the body, the symmetrical halves of the spinal column failing to coalesce, leaving a gap or chasm between. This separation may extend through the bodies of the vertebrae, or, as is more commonly the case, may be restricted to the arches and the spinous processes, leaving the spinal canal uncovered by bone. These arrests of growth are much more common at the lower than at the upper portion of the spine. This is in harmony with the development of the arches, which progresses from above downward. Cruveilhier, in his "Pathological Anatomy," mentions a case in which the arches were defective in the whole length of the spine. About 50 per cent. of all cases of hydrorachis occur in the lumbar region, 12 per cent. in the lumbo-sacral, and 27 per cent. in the sacral.

Hydrorachis.—As a consequence of incompleteness in the arches posteriorly, the membranes of the medulla spinalis press through the opening, forming a tumor, which is termed hydrorachis, and sometimes, though improperly, *spina bifida*, the latter term expressing only the vice of conformation which gives rise to the disease.

The common seat of hydrorachis is the lower lumbar (Fig. 1522) or the lumbo-sacral region. There are exceptions to this rule, the tumor being sometimes seen over the sacral, the dorsal, and even the cervical region. Exceptionally two or more tumors are present.

The protrusion occurs during the last months of intra-uterine life, and is often found associated with other congenital malformations, as hare-lip, cleft palate, hydrocephalus, club-foot, and paralysis of the lower extremities, the bladder, and the rectum. The formation of a tumor of this nature has occurred after birth.

The tumor varies in size from that of a hickory-nut to that of the foetal head. The base or attached portion is sometimes sessile, at other times pedunculated.

ANATOMY.—The external appearance of the tumor is not always the same. When the integument retains its normal thickness and its adipose tissue, the surface of the hydrorachis may differ very little from that of the adjacent skin, perhaps being a little more corrugated. The cutaneous covering is often extremely attenuated, so that the swelling is quite translucent, or the integument, like the vertebral arches, may be defective, when the surface of the tumor presents a red, raw appearance. Beneath the skin are the membranes of the spinal cord blended together to form the sac and distended with a limpid or straw-colored fluid. The source of this fluid is not always the same. It is either arachnoid or subarachnoid, according as it is derived from the cavity of the arachnoid membrane or from the vessels of the pia mater or of the cord.

The subarachnoidean or cerebro-spinal fluid is much the more common. It is limpid, of low specific gravity, having a neutral or faintly alkaline reaction, with perhaps the slightest trace of albumen, and containing some saline matters. A substance analogous in its chemical reactions to diabetic or grape sugar has also been described. The communication between the fluid of the subarachnoidean variety of hydrorachis and that occupying a similar space

FIG. 1522.



Hydrorachis.

in the brain has been well established. Pressure on the sac of a hydrorachis has been found to produce stupor, from the wave of fluid being forced back within the skull. In cases where, conjoined with the spina bifida, there existed hydrocephalus, the swelling of the head has been noticeably increased by compressing the spinal tumor.

The relation between the cord, the spinal nerves, and the sac is not always the same, but is determined by the location of the fluid, as has been shown by Mr. Hewett.

When the fluid is situated in the cavity of the arachnoid membrane, it forces the sac through the defect in the arches and at the same time presses the cord forward, so that the latter is in front of the sac. If the fluid contents of the tumor are cerebro-spinal, or situated beneath the arachnoid membrane, and the cord is adherent to the sac, the latter will contain both the cord and the nerves, which are forced backward.

Cases have been observed in which the inner surface of the sac was lined by an expansion of the cord and nerves. This condition is believed to be due to the fact that the spinal canal, in the early stage of development, extends through the entire length of the medulla spinalis, and communicates with the fourth ventricle of the brain. The cerebro-spinal fluid gravitating to the bottom of this canal expands it in all directions, so as to form a pouch of neurine within the sac. The presence of a body like grape sugar and the absence of albumen, which are said to distinguish the fluid of hydrorachis, are of doubtful diagnostic value.

DIAGNOSIS.—Tumors are met with over the lumbar or sacral region which might be mistaken for hydrorachis, especially cysts, which are occasionally seen exactly on the median line. Whether the growth is cystic, fibrous, or adipose, there is one important test which will usually serve to establish the diagnosis, namely, the existence of a completed arch with its spinous process, which can, in tumors other than those arising from the bifid spine, be discovered underlying the growth. In addition, the tenseness of a hydrorachitic enlargement during the crying of the child, and our ability to lessen its size by pressure, especially when the patient is turned head downward, will conclusively remove any obscurity which may exist. It has also been suggested in doubtful cases, particularly in cystic tumors, to examine the fluid, as that of hydrorachis (as already stated) sometimes differs from the liquid contents of other cysts.

SYMPTOMS.—The signs of hydrorachis are an enlargement or tumor, generally in the lumbar region, exactly in the median line or in the natural position of the spinous process, and around which may be felt the margins of the bony opening through which the tumor passes. The tumor, when the skin is attenuated, will probably be transparent, and when palpated will communicate the sense of fluctuation. When the child cries, some enlargement or tension may be detected in its walls.

As the growth increases, ulceration not unfrequently follows, which opens the sac and allows the contents to escape. Should the child not perish from convulsions, the opening may afterwards heal up, or a fistula may remain, through which a small amount of fluid will continue to pass. Sometimes the sac and skin become so extremely thinned as to permit a certain amount of fluid to exhale from the surface, without any actual lesion of the tissues. When the tumor contains a portion of the cord or its nerves, the pressure resulting from the increased accumulation of fluid in the sac will often induce paralysis of the lower extremities, of the bladder, and of the rectum. From the same cause convulsions are provoked, and the child dies; and, finally, in a very few cases, through the development of the arches, the neck of the sac will be gradually encroached upon, until at length its cavity becomes entirely disconnected with either the arachnoid or the subarachnoid space, when a spontaneous cure follows.

In a child which I kept under observation for two years at the clinic of the University Hospital, I watched with great interest this mode of spon-

taneous cure. The tumor gradually diminished in size, and its neck became contracted, until, finally, its connection with the body was reduced to the size of a small probe. The child grew, and became strong and vigorous. A little mass of what appeared to be the redundant integument of an extinct sac was all that remained, and this the mother was anxious to have removed.

As the case appeared to have been perfected for over a year, I was induced to clip the thread-like pedicle which connected the shriveled tag of skin to the body; to my surprise, I afterwards learned that a serous fluid was flowing from the end of the stump. The opening could not have been larger than a hair. I directed the medical attendant, Dr. Haynes, to pass a pin through the sides of the opening, including a considerable amount of tissue on either side, and bring the parts together with a figure-of-eight suture. The operation proved successful, and the child made a permanent recovery.

As a rule, however, children affected with hydrorachis die in five or six months after birth. A few instances have been recorded in medical writings in which the subjects of the disease have reached adolescence, and even mature manhood. Among the latter is the case of Behrend, of a man who reached the age of fifty-one, and another of Moulins, of Bordeaux, who lived to thirty-seven.*

TREATMENT.—In the large majority of cases of hydrorachis nothing can be done towards effecting a cure, and very little in the way of palliation. Many of the attempts which have been made by enthusiastic surgeons to remove the disease have been ill-timed and contributed to hasten the fatal event. It must not be forgotten that when the base of the tumor is sessile, and contains, as it generally does, a portion of the spinal cord or its nerves, it matters not what plan is adopted, whether the ligature of the growth, as suggested by Bell, or puncture and pressure, as practiced by Abernethy and Sir Astley Cooper, or compression with the clamp, the device of Wilson, of England, or injection, the method of the late Dr. Brainard, of Chicago, or excision, all must terminate in the same unfortunate manner, precipitating death by paralysis or convulsions.

When the tumor is pedunculated, a form which hydrorachis tends to assume; when the defect in the posterior wall of the spinal canal is small, or when the developmental force continues operative and the arches grow towards each other, thus encroaching on the mouth of the sac, there is often a tendency to a spontaneous cure; and if the neck of the tumor continues to lessen, there is some reason to believe that it is largely liquid and contains no very important nerve-trunks.

These are the cases which tempt the surgeon; but, though the most inviting, even in them the operation is by no means devoid of danger.

A safe plan of procedure in all such cases is to have the child carefully watched, and, as long as the natural process of pedunculation is progressing, to refrain from active interference. Should this process become stationary, and the health of the child continue undisturbed, I should still abstain from any operation. If, however, the tumor enlarges and general symptoms arise of a threatening nature, an operation is not to be declined.

The indication is to obliterate the communication between the sac and the spinal canal; and the plan which commends itself as the most favorable, both from its simplicity and its occasional effectiveness, is the injection of the sac with tincture of iodine. Brainard, who introduced the practice, claims to have cured three cases out of seven,—a success, I may remark, which no one since has obtained.

In using the injection, in sessile tumors, an indirect subcutaneous puncture of the sac should be made with a delicate trocar, which is thrust through the sound skin adjacent to the tumor. After drawing off about one-half of the fluid, leaving enough to maintain a sufficient degree of pressure on the spinal cord to prevent convulsions, an injection should be thrown into the sac varying in strength according to the form of the tumor, whether pedun-

* Bulletin de la Société de Chirurgie, 1860.

culated or sessile. For the latter it should consist of one grain and a half of iodide of potassium and one-fourth of a grain of iodine to the ounce of distilled water; in the case of a pedunculated tumor, fifteen grains of the iodide of potassium and five grains of iodine to the same quantity of water. The canula should then be withdrawn and the puncture in the skin covered with a strip of adhesive plaster. When the tumor is pedunculated, its contents are to be entirely removed, and, after injecting the sac and allowing the fluid to run out, it should be partially refilled with the cerebro-spinal fluid first drawn, which is to be preserved for the purpose at a proper temperature, or with distilled water. During the injection the neck of the sac should be compressed, in order to prevent the iodine from entering the spinal canal. If the operation results favorably, the inflammation which is developed in the sac will close the communication at the neck of the tumor, between its cavity and that of the spine, and thus cure the disease. When the method of injection is resolved on, it should, in my judgment, be confined to cases of pedunculated hydrorachis.

General Phenomena following Spinal Injuries.

In consequence of the relation which the spinal marrow, through its nerves, sustains to almost every portion of the body, the phenomena which follow its injuries are no less remarkable for number than for variety. It will be proper, therefore, to present a general *résumé* of the different morbid effects which follow spinal traumatism. These vary according to the particular region involved.

Paralysis.—Thirty-one pairs of nerves make their exit from the cord through the intervertebral foramina, conferring on the muscles of animal life motion and sensation. Consequently, paralysis is one of the most constant phenomena following severe injuries to the spine. This paralysis may be motor, sensory, or moto-sensory, the latter being most common. Although in most cases of severe injury of the spinal centres motion and sensation are alike lessened or destroyed, indicating that the lesion has affected the entire segment of the cord, yet there are instances in which the loss of one function alone occurs, or in which the two are very unequally affected. The explanation of such accidents, now that we understand the anatomy and physiology of the medulla spinalis, is simple, as they indicate that the damage is limited to one column more than to the other. The paralysis usually extends to all that portion of the body below the seat of injury, or, rather, to all the muscles which receive their nerves from the section of the cord implicated. One portion of a limb or one group of muscles may be paralyzed while the others retain their movements. Bilateral paralysis is the rule, unilateral the exception, after injury of the spine. When the loss of power is one-sided, it implies that the lesion affects only one lateral half of the cord. Though the paralysis affects usually only those parts below the seat of damage to the cord, there is a possibility that loss of power may extend somewhat to portions of the body above. When this is the case, the paralysis is always secondary, and is due to inflammatory changes or to hemorrhages in the medulla spinalis.

To formulate with more detail the phenomena following injuries of the spinal cord, they are best presented on a physiological basis, as observed by Brodie.

In paralysis of the bladder there is first retention, often followed by incontinence of urine. The urine undergoes a change, becomes strongly alkaline, dark-colored, and loaded with mucus, pus, and phosphates. It decomposes, emits a highly offensive odor, and becomes a violent irritant to the mucous membrane of the bladder, developing at length a serious cystitis, and occasionally even sloughing of the mucous membrane. It is often increased in quantity, sometimes diminished, but rarely entirely suppressed. Blood in the urine is common after spinal injuries, but it is to be attributed more to renal concussion than to the violence applied to the spine. Sometimes, after vesical paralysis, there is seen a singular instability in the chemical reaction

of the urine, which is one day alkaline and the next day acid. It may be diabetic when the injury involves the cervical part of the cord.

As the muscular walls of the abdomen and of the intestines receive their nerves from the lumbar portion of the medulla spinalis, both are liable to suffer: hence the flaccid and insensible state of the first, and the gaseous distention of the latter, which follow accidents to this part of the spine.

When the lumbar section of the spine is involved, the paralytic effects are not uniform, inasmuch as the cord proper terminates about the second vertebra of this region, the remainder of the canal being occupied by the cauda equina, the nerves of which are not likely to participate in an injury. While, therefore, paraplegia may occur, the loss of power often affects merely the continence of the bladder or the bowel, or one or two groups of muscles below.

As we ascend the vertebral column through the dorsal and cervical regions, we find, with each segment of the cord injured in the ascent, an additional number of muscles deprived of power, as the abdominal, the thoracic, and those distributed to the upper extremities, until at length, when the lesion occurs above the fourth cervical vertebra, death follows suddenly, in consequence of the nervous communication between the diaphragm and the phrenic nerve being interrupted.

Hyperæsthesia.—Though loss of sensation is a common accompaniment of motor paralysis, there may exist an unusually exalted state of sensation, —hyperæsthesia. There may be motor and sensory paralysis on one side and hyperæsthesia on the other. There is in such cases probably a slight degree of injury to the posterior column of the cord, or to the roots of those nerves that leave that portion of the cord which supplies the super-sensitive district. The suffering which accompanies this condition is often excruciating when the part is touched, and the surface of the hyperæsthetic region frequently presents a red or mottled color, and a glossy, shining, or polished appearance.

Pain.—Among other phenomena, pain is frequently witnessed. It is experienced sometimes at the injured part of the cord, and at other times at points remote from this centre, in a particular group of muscles, in the fingers or the toes. The character of the pain varies, the shades of distinction being expressed by the terms burning, pricking, tingling, scalding, darting, twisting, and constricting, or cord-like.

Muscular system.—When the pressure or lesion is not adequate to produce paralysis, the effects on the muscular system are often very striking. These are manifested sometimes in twitchings, in irregular or spasmodic movements of certain muscles, in general convulsions, or in a persistent rigid contraction of one or more muscles. Though they are supposed to have some diagnostic significance as indicating spinal compression, I am not prepared to believe that the connection between the two is sufficiently uniform to constitute a reliable basis for any such conclusion. As signs of meningitis and of myelitis, they are, however, not without value.

Elevation of temperature.—An increase of temperature in the paralyzed parts is another effect. It is more pronounced when the cervical portion of the cord has been injured, probably from the relation which this part of the spinal centre holds to the sympathetic nerve. Experiments in the thermometry of paralyzed limbs, made by Brodie, Hutchinson, and others, show an increase of temperature, amounting to from two to eight degrees. This phenomenon must be referred to the loss of that regulating power over the walls of the vessels which is possessed by the vaso-motor system of nerves, in consequence of which the paralyzed parts become overcharged with blood. The local heat is subjected to alternations, rising and falling with a kind of periodicity, though when such fluctuations are observed the paralysis is not complete. A constantly high temperature foreshadows danger in the near future. The degree of actual heat may be in striking contrast with the sensations of the patient, which are often those of cold.

Eye and lachrymal gland.—When the cervical part of the medulla spinalis has been damaged, certain symptoms appear which belong peculiarly to this part of the cord, and which are due to paralysis, more or less complete, of the sympathetic nerve, between which and the spinal system communication is established through its cervico-cephalic branch. The symptoms originally noticed by Brodie, and subsequently by Brown-Séquard and others, consist in lachrymation, contraction of the pupils, flushed face, redness of the conjunctiva, sometimes strabismus, and an increase of vital heat. These signs, indicating as they do extensive damage to the cord, are to be accepted as of the most serious character.

Dyspnœa.—This symptom will attend injuries of the cord in the dorsal or in the cervical region, as from both of these the muscles concerned in respiration receive their nerve-endowments. From the dorsal portion are derived the intercostal nerves, which supply the intercostal muscles, and also branches distributed to the serrati muscles; and from the cervical division of the medulla come the long thoracic and phrenic nerves, which supply the great serrati muscles and the diaphragm. The difficulty of respiration will, therefore, be increased in proportion to the height at which the injury implicates the cord. The occurrence of dyspnœa as a secondary effect of spinal injury is an extremely unfavorable sign, betokening, as it does, central changes of an incurable character, as inflammatory softening of the cord. In these distressing cases of embarrassed respiration the difficulty is increased by the intestines becoming distended with air and pressing upward against the diaphragm.

Genital organs.—Priapism is the most noteworthy symptom observed under this head after lesion of the spinal cord. It is entirely independent of the will, and is neither produced by nor attended with any voluptuous sensation. It may be occasional or continuous, and is generally to be interpreted as an unfavorable sign, indicating hemorrhage into the cord; though I have witnessed this condition where the cord had received no serious damage, the patients entirely recovering. Priapism is most commonly seen after injury to the cervical part of the cord, though the symptom has occurred in patients in whom the lesion was located in the dorsal or in the lumbar region. It is among the phenomena commonly observed in the execution of criminals by hanging.

Even in moto-sensory paralysis, priapism, as was first pointed out by McCartney, can be excited by mechanical or reflex irritation, as the introduction of the catheter. Hilton, in order to explain priapism following lesions of the spinal cord, refers the condition to the deprivation of that portion of the medulla spinalis below the injury, of the inhibitive power possessed by the brain over the excito-motor phenomena of the genital organs.

Circulatory system.—Injuries to the upper dorsal and lower cervical portions of the cord, in virtue of the connection which exists between the cervical and the dorsal ganglia of the sympathetic nerve, produce well-marked impressions on the heart, which are indicated by retardation of its action. The vessels of the pericardium become overdistended with blood to a degree which may cause a free transudation of serum. Hyperæmia occurs at all points which have become paralyzed. The vessels, especially the deeper ones, are not only surcharged with blood, but the circulation moves more sluggishly through them in consequence of the vaso-motor paralysis which accompanies the paralysis of the voluntary muscles.

It is the absence of an active capillary circulation and the fixedness of position necessitated by the deprivation of sensation and motion, which, in paralysis, leave those portions of the body and of the extremities subjected to pressure so prone to suffer from bed-sores.

Deglutition.—Difficulty in swallowing is also an attendant of spinal injuries when seated high in the cervical region, the disturbance to the function being the result of involvement of the glosso-pharyngeal and pneumogastric nerves; and it is probably in consequence of communications of the last-

named nerve with the cord that jaundice sometimes follows injuries to the dorsal region of the spine, and that distressing vomiting results from accidents to the cervical part of the cord.

Effect on nutrition.—Two causes operate to disturb the nutrition of a paralyzed part, namely, the absence of motion and the want of a sufficiently active interchange of materials between the blood and the components of the tissues concerned. Hence we have wasting of the muscles, disappearance of the fat, roughness of the skin, extensive epithelial desquamation, arrest in the growth of the nails, emaciation, rigidity of the articulations, and, not uncommonly, vicious contractions of the limbs. It is true that there are many exceptions to the wasting of paralyzed parts. Very often this feature is as noticeable in the pseudo-paralysis of hysteria as in that which is real, occasioned, it is thought, by the fact that true paralytics are always making efforts to move the disabled muscles, the stimulus of which is supposed to contribute to their nutrition, while in paralysis from emotional causes this is not attempted. I doubt very much the correctness of this explanation, however, and believe we must seek for the true cause in such degenerations of the medulla spinalis as render the cord incapable of receiving reflex impressions or such destruction of the nerves as to make the transmission of any influence, sensory or motor, impossible. In support of this view may be adduced the fact that the absence of atrophy is far more common in hemiplegia than in paraplegia, the decussation of nerve-fibres rendering the supply of some voluntary nervous energy still possible to the affected muscles of the hemiplegic.

The blood itself is not exempt from morbid changes. A young lady whom I visited in connection with Dr. James Darrach, of Germantown, had, six months previously, fallen several times while engaged in skating, striking on the nates and the sacrum. Though at the time of these several accidents she was conscious of being hurt, the injuries were not sufficiently severe to induce her to abandon the amusement, until, finally, pain across the hips and weakness of the lower limbs compelled her to relinquish this, and at length almost every other kind of exercise. When I saw her, the body and limbs were emaciated, and the skin was rough like the surface of a nutmeg-grater. When she walked across the floor it was with a rocking, side-to-side movement, the extensors possessing very little power. Numerous subcutaneous patches of extravasated blood were seen, particularly over the legs, and she was bleeding freely from the gums. Previously she had suffered from obstinate vomiting. Death occurred two weeks after my visit, but no autopsy was allowed.

Cerebral symptoms have been described as the result of spinal injuries, as headache, delirium, insomnia, loss of memory, irascibility, etc. These, when present, must be classed as secondary manifestations, either developed in consequence of an extension of meningeal inflammation to the brain, or due to the skull suffering in common with the spine from the vulnerating force.

DIAGNOSIS.—The affections with which the secondary effects of spinal injuries may be confounded are hysteria, rheumatism, and concussion of the brain. From hysteria the following considerations will be sufficient to establish the distinction:

HYSTERIA.

A disease of women.
Emotional element dominant from the first.

An affection, generally, of the young.
Paroxysms of suffering irregular and intermittent.
Sensibility of the surface exaggerated.
Never ending in paralysis.

SPINAL DISEASE.

Not confined to either sex.
Secondary, and only after a considerable time has elapsed between the accident and the morbid symptoms.
Peculiar to no age.
Continuous or progressive.

Very little increase of sensibility, if any.
Often ending in paralysis.

Rheumatism possesses many peculiarities in common with the secondary phenomena attending traumatic disease of the spinal cord or its membranes.

In both there are pain, stiffness, and undue sensibility along the course of the spine, with muscular disability; but a careful inquiry will succeed in detecting points of difference. They may be arranged as follows:

RHEUMATISM.

Not necessarily preceded by any injury.
Pain, uneasiness, soreness, and stiffness local.

Attacks sudden and non-progressive in severity.
In motion pain is referred to a particular point.
Indisposition to muscular motion, due to the pain and uneasiness produced.
Often accompanied with rheumatism of other articulations.
No eccentric sensations.

Often a rheumatic history.
Urine loaded with urates.

EFFECTS OF SPINAL INJURIES.

Always a history of such injury.
Not local, but diffused, or at several distinct points at the same time.
Attacks slow and progressive.
General rather than confined to a small area.
Same symptom due to inability, the result of diminished power or of paralysis.
No concomitant articular disease.

Tingling, creeping, and burning sensations in the cutaneous nerves.
No such history except as a coincidence.
Urine containing phosphates, particularly of lime.

The differential diagnosis between the secondary effects of cerebral concussions and injuries of the spinal cord must be based on the previous history of the case, and on the nature and locality of the symptoms. In both there may be muscular weakness and spasms, paralysis of the sphincters, and psychological phenomena. Contrast the following points:

CEREBRAL CONCUSSION.

Force usually received on the head.
Pain or uneasiness in the head primarily.
Any distortions or paralysis of the muscles which may ensue are preceded by head-symptoms, as cephalalgia, irritability of temper, or insomnia.
Pain, rigidity, and abnormal sensibility of the spine on movement or pressure sometimes but not invariably present.

SECONDARY EFFECT OF TRAUMATIC INJURY OF THE SPINAL CORD.

Force usually applied more directly to the spine.
In the course of the spine.
No such sequence of symptoms.

All of these symptoms usually experienced.

Should cerebral and spinal symptoms coexist, as is sometimes the case when force of unusual severity has been applied to the body, either at the cranial or at the sacral extremity, it will be impossible to calculate the symptomatic proportion due to each, though, reasoning from the greater vulnerability of the brain, when the skull has received the first impact of the violence it will be fair to infer that the cerebral factor is the dominant one.

PROGNOSIS.—In no class of injuries is the prognosis so unfavorable as in those which follow lesions of the spinal cord. Death may be instantaneous, particularly when the lesion involves the cervical portion of the cord; or it may follow a protracted invalidism, which wears the sufferer out by complications arising in the progress of the case. The causes of death from all kinds of spinal injury are shock, asphyxia, cystitis, meningitis, myelitis, disease of the brain, and bed-sores or sloughing. In the few cases of recovery after spinal injury, accompanied by paralysis, the improvement has been very slow.

TREATMENT.—In the early stage of all spinal injuries involving the cord, nothing exceeds in importance *rest*. In the absence of paralysis, or when the muscular weakness is only slightly present, and when hemorrhage or inflammatory consequences are apprehended, the prone position advocated by Mr. Erichsen in concussion of the spine is to be preferred for a time, though it is one which is difficult to maintain for any protracted period. The posture is one which brings to our aid a valuable adjuvant in the treatment either of hemorrhage or of inflammatory determination, namely, that of gravitation. Cups may be applied along both sides of the spine, first wet, and subsequently dry, and, if the temperature rises, an ice-bag can be advantageously placed over the same region.

When paralysis follows the injury, the procuring of a water-bed is of the utmost moment. The dorsal position now becomes necessary, and the prevention of bed-sores, even with every precaution, is not always possible. When a hydrostatic bed cannot be commanded, a firm hair mattress is to be preferred to one made of softer materials, and sloughing is to be guarded against by daily frictions of the salient parts of the body with alcohol, and by using pads and rubber air-cushions, by which the pressure can be shifted to other parts.

The condition of the bladder will demand early attention, as often the viscus is unable to get rid of its contents, and will require catheterization at stated periods, usually three times during the twenty-four hours. Only by faithfully discharging this duty can the evils of cystitis be prevented. The soft gum Mercier catheter is the proper instrument to be used, and, with a little instruction, the operation may be safely intrusted to an attendant. The bowels are to be kept open, when a spontaneous evacuation does not take place, by stimulating enemata, and the utmost attention must be given to cleanliness of bed-clothing and of the person of the patient, that excoriations and sores may be avoided. When there is reason to suspect the existence of meningitis or myelitis, the local abstraction of blood by cups will be indicated, and the administration of alterative doses of mercury, preferably the bichloride, which can be continued for a longer time than calomel without causing salivation.

After the acute symptoms have passed over and there remains only the paralysis, the use of tonics, with some stimulation of the spinal centre, may be very cautiously attempted. For the above objects quinine, iron, and strychnine constitute the best combination; but the closest supervision will be necessary for a time, to see that no aggravation of the symptoms follows, which is likely to be the case in the event of any intra-spinal inflammation still lingering about the damaged parts.

To prevent the wasting of the muscles and to preserve the skin in a healthy state, resort should be had to the judicious use of "massage" and systematic movements of the paralyzed parts. Should the patient so far recover the use of the limbs as to be able to stand or to walk about, the application of a plaster bandage or of a leather splint to the spine will materially contribute to the power both of support and of motion.

Curvatures of the Spine.

Anatomical peculiarities.—The natural curves of the spinal column are all antero-posterior, with a very slight lateral one at the upper part of the dorsal region, which is thought to be due to the influence of causes connected with the very general use of the right hand. The antero-posterior curves are alternately arranged as follows: in the lumbar region the concavity is posterior and the convexity anterior; in the dorsal region the concavity is anterior and the convexity posterior; while in the cervical portion of the spine the disposition of the curves is the same as in the lumbar, namely, concave behind and convex in front. (Fig. 1523.) These curves are produced partly by the increased vertical extent of the bodies of the individual vertebræ, and partly by the intervertebral cartilages.

FIG. 1523.



Curves of the vertebral column.

All of the spinous processes of the cervical vertebræ have a horizontal relation to the bodies of the vertebræ, and that of the seventh is so long as to have received the name of *vertebra prominens*. Those of the lumbar region are similarly disposed, while those of the dorsal division of the column are bent downward or imbricated, one overlapping the other. Throughout all the region of the vertebral column the spinous processes are accurately in line.

Along either side of the spine are lodged powerful muscles, the tendons of which are inserted into the lever-like processes of the vertebræ. These not only serve to preserve the erect position of the body, but also, by exerting an equally-balanced traction on the spine, keep it from inclining to the one side or the other.

The above anatomical and physiological facts will materially aid the physician in the diagnosis of spinal curvatures.

There are three curvatures observed in the spine, namely, lateral, antero-posterior, and rotatory, the last being induced by changes resulting from the two other conditions.

Curvatures of the spinal column are the result of causes quite dissimilar in their nature. Those generally concerned in causing the abnormal deviation are, *first*, unequal exercise of muscular power on the two sides of the column; *second*, occupations; *third*, alterations in other parts of the skeleton demanding spinal compensation; *fourth*, structural changes in the vertebræ, in their cartilages, or in both.

Lateral Curvature.

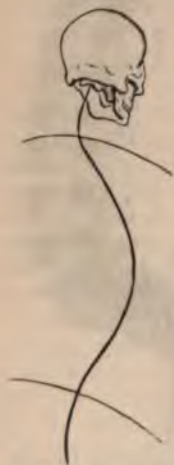
Lateral curvatures are seen both in the young and in adults. Among the first class the chief subjects of the deformity are girls, and occasionally boys, between the ages of eight and fifteen.

The curvature is sometimes in the lumbar and sometimes in the dorsal region. Coincidentally with the primary, which may be called the pathological curve, there are formed two others, which are compensatory, and grow out of the necessity for maintaining the erect position. Thus, if the primary or pathological curve is in the lumbar region and directed to the left side, the compensatory one will form in the dorsal region and be in the opposite direction, or to the right side, while this, in turn, begets the necessity for a third in the cervical region, to restore the line of support, imparting a serpentine appearance to the column as a whole. (Fig. 1524.)

In marked cases of deviation of the spine there is also a rotatory curvature, produced, in my opinion, by the contraction and shortening of those slips of the longissimus dorsi and sacro-lumbalis muscles which are inserted on the angles of the ribs and the transverse processes of the lumbar and dorsal vertebræ. This rotatory curvature may become so great that the angles of the ribs and the transverse processes of the vertebræ, being carried backward, will finally occupy almost accurately the normal position of the spinous processes.

When the curve previously affects the dorsal region of the spine, it has been supposed by Professor Sayre that the rotatory precedes the lateral deviation, the serratus magnus muscle being the chief factor in causing the deformity. Whether this is the initial stage or not, there can be no doubt in regard to the influence of the above-named muscle in the production of the deformity, as its oblique position on the side of the thorax and its connection with the spine through the rhomboid muscle, making it practically a digastric muscle, are highly favorable to such a result.

FIG. 1524.



Primary and secondary lateral curvatures.

Lateral curvatures begin most frequently in the dorsal region, preferably in its upper part and on the right side. Why this predilection for the right side exists it is difficult to explain, unless there is in the curve natural to this side a determining influence, which seems to me probable.

CAUSES.—The causes of lateral curvature are various. Of course, some advantage gained by the muscles of one side over those of the other side is immediately concerned in causing the deviation, but what it is which confers this advantage—that is, the remote cause—is not always easily ascertained. A general weakness of the muscles or of the system at large certainly does not enter exclusively into the causation. Weak, delicate girls and boys are not more frequently the subjects of spinal curvatures than the strong, muscular, and robust.

1st. I am disposed to think that *the partial or unequal use of the muscular system* is most commonly concerned in developing lateral spinal curvatures. The boy or the girl freed from the artificial restraints of society, and left to follow without check the multitudinous versatility of romp, play, and amusement, which are natural and instinctive to young life, rarely, in my observation, suffers from a distorted spine. Contrast with this child of liberty, whom we will adopt as a type, one who is constantly being instructed in the school of Procrustean proprieties, who must walk after a particular fashion, carry the head and the pelvis in a prescribed manner, sit for nine hours out of the twenty-four at study, either at home or at a desk at school, without, in all probability, any support whatever for the back; who in going to and from school carries, almost invariably on one side, a formidable number of books, who has a minimum of fresh out-door air, and whose only amusements consist in dancing and the use of grace-hoops, and you have a subject admirably adapted to become the prey, among other infirmities, of the muscular disability under consideration.

The same effect may be produced by the exactions incident to the other extreme of the social body. The factory-slave, doomed often to the standing position for many consecutive hours in a close atmosphere loaded with foreign matter, obliged to take hurried meals, frequently less nutritious than they should be, is in danger of drawing too largely on the capacity of the spinal muscles, and, by destroying the equilibrium of support, causing the column to deviate from the proper line. To social influences, therefore, I attribute a very large proportion of all cases of lateral spinal curvatures. It is the city, not the country, which swells the ranks of spinal deformity.

2d. *Unilateral muscular atrophy*, allowing the spine to deviate from the perpendicular, may be the result either of peripheral or of central causes. Among the former are to be enumerated blows and sprains, in consequence of which the nutrition of the injured muscles becomes so impaired that wasting follows.

Central atrophy of the spinal muscles is more common than is generally supposed. Here the seat of the trouble is in the spinal cord, and has the same pathological significance as infantile paralysis. The wasting is gradual, and often supervenes on an attack of some disease of childhood, as diphtheria, whooping-cough, or convulsions.

3d. *Unilateral muscular hypertrophy*.—The muscles on one side of the spine may, in consequence of certain occupations, become more developed than those of the opposite side, and consequently draw the column in the direction of superior power. Adults generally furnish examples of this variety of curvature, and among these, blacksmiths, tailors, and sewing-women are the persons most affected. A habitual careless position of the body will conduce to similar deformity.

4th. *Muscular spasm*.—Occasionally one or more of the muscles on one side are seen to be in a state of permanent contraction, the effect of which is ultimately to bring about a lateral inclination of the column. This condition may properly be referred to a central cause located in the spinal cord, and in this respect is similar to that contraction which is often seen in torticollis.

5th. *Rachitis*, affecting as it does the structure of bones, and depriving them of the resistive power necessary to withstand the conjoined effects of pressure and muscular contraction, frequent in childhood, produces lateral curvatures of the spine, in common with similar distortions of other bones of the skeleton.

6th. *Alterations in the length of one of the extremities*.—Whatever produces shortening of one of the lower extremities is followed by a tilting of the pelvis in the opposite direction, and this in turn by a compensating lateral curve in the spine, in order to preserve the line of gravity. Thus, in coxalgia and after excisions of the knee-joint we find this change. In like manner, after amputations of the arm high up, or at the shoulder-joint, a curve gradually forms in the spinal column from the superior weight of the opposite side.

7th. *Morbid growths* of the sides of the body or pelvis, as encephaloid sarcoma or enchondroma, often attain an enormous bulk, and, by the drag they exert, call into activity the same movements which conspire to resist the effects of pelvic obliquities and which produce compensatory curves of the spine.

8th. *Sacro-iliac disease* is also liable to cause lateral curvature, from the habit which the patient acquires of leaning away from the affected side, in order to obtain relief from suffering by the extension produced by the weight of the suspended limb.

In addition to the above causes of lateral spinal curvature, there are defects in the development of individual pieces of the vertebral column, as irregularity of size and undue obliquity of articulating surface, which neutralize the proper action of the muscles. Similar effects may be induced by rheumatism of the lumbo-dorsal muscles, destroying their proper bilateral antagonism.

SYMPTOMS.—The signs of lateral curvature are both local and constitutional. When the curve is dorso-lumbar, including the lumbar part of the spine and probably the lower third of the dorsal, there are seen, in well-pronounced cases, two prominences, one on each side. The one on the convex side of the curve is muscular, and caused by the stretching of the spinal muscle over the salient transverse processes; the other, or that on the concave side, is bony, and formed by the crest of the ilium, which is rendered unusually conspicuous by the sinking in of the abdominal parietes above. As all the vertebræ within the limits of the curve move together, it is not likely that there will be any marked deviation in the relations of the spinous processes to one another.

When the curve is limited chiefly to the dorsal region, the lateral deviation of the spinous processes from the line of those belonging to the concealed lumbar portion of the spine may be felt, but not seen; the muscles over the convexity of the curve are prominent, as also are the corresponding scapula, and, in well-marked cases, the angles of the ribs of the same side. On the concave side of the curve the muscles are flattened and sunken, and the angles of the ribs have receded from the surface, in consequence of the accompanying rotation of the spine. The shoulder of the same side will be observed to be lower than its fellow. This inequality in the level of the shoulders and the undue prominence of one of the scapulae is often the first sign of the disease detected. (Fig. 1525.) A boy complains of one of his suspenders constantly slipping off the shoulder, or a girl of her inability to keep the shoulder-straps of her dress in place. This should attract attention at once to the spine, as it often indicates the beginning of spinal curvature.

When the pathological or primary cause calls into existence the compensatory or secondary curves, and the lateral are well distributed, the deformity of the body is less noticeable, notwithstanding the serpentine or undulating form of the column, as the two extremes of the column, the occipital and the pelvic, are in line, though the centre of gravity passes through the concavities of the curves instead of their summits, as in the normal spine.

The prominences of the dorsal spinous processes are greatly lessened, or may entirely disappear, and the back may be markedly flattened. If the curves are well marked, the effects will be seen also in the conformation of the anterior part of the thorax, the left breast being more prominent, in conformity with the prevailing frequency of right-sided curvature, and directed somewhat to the left side by the spinal rotation. If the disease proves progressive, and is left to itself, a time comes when these curves are very unequally increased, and, consequently, all the characteristic deformities become more and more conspicuous.

In slight cases of lateral spinal curvature the general health may not be materially affected, but in more marked cases the patient frequently complains of muscular weakness, being tired on taking exercise, and disposed to seek relief by lying or sitting down. Palpitation of the heart, shortness of breath, and disturbances of the digestive organs are also not uncommon accompaniments of the distortion.

STRUCTURAL ALTERATIONS.—If we take a spinal column in the recent state, with its ligaments and cartilages intact, and forcibly bend it laterally, it will be seen that the effects of such force will be expended chiefly on the intervertebral disks of cartilage and on the articular processes. Both are compressed on the concave side of the curve, while on the convex side the cartilages, being relieved from pressure, become expanded, and the ligaments of the articulations become tense. This is just what occurs in lateral curvature, and the effect of such pressure and stretching constantly acting on these living structures is to cause the absorption of both cartilages and vertebræ on the concave side of the curve, as also of the articulating facets of the transverse processes. The latter, as shown by Mr. Alexander Shaw, being soft in early life, suffer in a very marked degree, and, as their articular surfaces slope downward and backward, the mechanism concerned in the rotatory displacement of the column becomes apparent. With the absorption of the cartilages, bodies, and articulating processes on one side, there is an elongation of the articular ligaments of the opposite side, which allows of both lateral and rotatory curvature.

In addition to these changes, the lateral flexion and horizontal rotation of the vertebræ necessarily produce a change in the position and form of the transverse processes, which become on the convex side of the curve unduly prominent along the outer margin of the erector spinæ muscles and abnormally separated from one another. The traction to which they are subjected on this side is sufficient to cause them to assume a curved shape, while on the opposite or concave side they may be found flattened from being crowded together. In like manner the ribs on the concave side are in contact with one another, or even overlap, obliterating the intercostal spaces, while on the opposite side they are separated from one another. (Fig. 1526.) The effect of these distortions, especially on the contents of the thorax, is to cause considerable displacement of the heart, lungs, and other components of the cavity, and to affect in some degree their functions; hence the palpitation and shortness of breath often witnessed in cases of this nature. The nerves which emerge through the intervertebral foramina on the concave side of the

FIG. 1525.



Lateral curvature of the spine.

lateral curve participate in the evil effects of pressure, and as the nutrition of the muscles on the same side depends largely on the integrity of these

FIG. 1526.



Structural alterations induced by lateral curvature.

nerve-trunks, especially the motor, we find muscular weakness and atrophy keeping pace with each other, often accompanied with flatulence, from a similar loss of power in the muscles of the intestines, which are energized from the same source.

TREATMENT.—The treatment of lateral curvature is both constitutional and local. Without the former the latter will often prove of little avail.

CONSTITUTIONAL TREATMENT.—Every hygienic surrounding should be made to conduce to the improvement of the general strength of the body. Fresh air, less restraint, less study, a less sedentary life, entire freedom of the body from the constriction of clothing, bathing, abundance of sleep, periodical rest in the recumbent position, and, where the patient is feeble, with little or capricious appetite, tonics, as cod-liver oil, iron, and the phosphates, will be demanded.

In very young children, confinement on the back, in which position they can be carried out in the open air by the nurse, will be required until the muscles acquire additional strength; and during this period of recumbency they can be materially invigorated by systematic "massage."

LOCAL TREATMENT.—Too often we find physicians, on the first appearance of the deformity, flying to instrumental applications to correct or to prop up the spine. Nothing can be more unphilosophical or injurious. The moment the trunk is encased in jackets, corsets, or any of the various other contrivances of steel and leather which figure in the books, keeping the muscles in a state of rest, these important levers, on which our hopes of improvement or of cure concentrate, begin to waste, and become more and more disqualified to support the body. Instead, therefore, of resorting to these contrivances in the beginning of lateral spinal curvature, the practitioner should devote his attention to the education, training, and development of the

faulty muscles, and, as much as possible, to diminishing the action of those which are concerned in producing the deformity. Numerous resources are at command to effect these objects, and the interest of the patient must be heartily enlisted in the matter, so that he may fully co-operate with the physician. For example, a certain portion of the day should be devoted to carrying some light weight, as a book, a little bag of shot, or some other body, upon the top of the head, while the patient walks to and fro: the attention that is necessary to poise the body aids in straightening the column by stimulating, through the will, the defective muscles. Another part of the day must be given to practicing those movements which chiefly affect the disabled muscles, as swinging by the arms, inclining the body in a direction opposite to the curve, or sitting on an inclined plane, which will necessitate the bending of the body in the same direction in order to resist the tendency to slide down. Another and a powerful measure is the plan introduced by Dr. Lee, of Philadelphia, of suspending the patient, after the manner described under the head of treatment in Pott's disease. The effect of this plan is to straighten at once the spine, and it should constitute a part of the drill for at least five or ten minutes every day. The patient can manage this part of the treatment alone, and need not raise the body higher than to allow the tips of the toes to touch the floor. One hour on the back in bed should always follow the extension. In addition to these means, the faulty muscles should be kneaded, pinched, and beaten, so as to invite a large supply of blood and improve the nutrition. An excellent muscle-beater is one which consists of a hollow gum ball attached to a flexible rod.

Electricity, in the hands of one familiar with the nerve-points most directly related to the muscles involved, also constitutes an excellent stimulus.

The function of respiration may likewise be utilized in helping forward the work of correcting or arresting these deformities, to obtain the full benefit of which it is necessary to have an apparatus—that of Briggs or of Davis being the best—which consists of metal or leather pads, which are placed one under the axilla on the concave side of the curve, a second over the most prominent portion of the convexity, and a third and fourth over the opposite hips. These several pads are connected with one another by bands con-

FIG. 1527.



Kolbe's apparatus for lateral curvature of the spine.

FIG. 1528.



Davis's apparatus for lateral curvature.

sisting partly of elastic material, and made fast by buckles. (Figs. 1527 and 1528.) The transmission of power during inspiration through these

lines of communication between the pads, making pressure and counter-pressure at different portions of the thorax and pelvis simultaneously, favors the correction of the distortion both by the movement of respiration and by the voluntary efforts to pull in the same direction. It should not be worn continuously longer than two or three days.

When the curvature is due to an inequality in the length of the lower extremities, it can be best remedied by elevating the shortened member by an addition to the sole of the shoe, by a cork shoe, or by a patten.

When the curvature is accompanied by muscular contractions, subcutaneous myotomy will remove an important obstacle in the way of correcting the deformity. Guérin, of France, at one time practiced this operation, but the empirical manner in which it was done tended rather to stigmatize than to commend the procedure. Sayre individualizes the faulty muscle by testing its reflex. The shoulders are raised or the body is bent opposite to the curve. If any muscle starts out prominently, or, on being pinched, pressed, or tapped, contracts spasmodically, or excites spasms in other groups of muscles, it is an offender, and is to be treated with the knife.

Cases will sometimes come under notice in which the curve increases so rapidly as to demand the temporary use of the plaster, leather, or steel jacket. (Fig. 1529.) The plaster appliance is to be preferred, inasmuch as its renewal once every six weeks becomes necessary,—the spine being extended at each dressing. (See Fig. 1540.) After the curvature has been in a measure corrected, the leather jacket may be substituted for the one of plaster,—always removing it at night, or when the patient is recumbent. When the ligaments become firm, and union of the epiphyses and diaphyses of the vertebra takes place, mechanical supports may be laid aside.

FIG. 1529.



Kolbe's spinal jacket.

FIG. 1530.



Posterior curvature in an aged woman.

Posterior Curvature (Cyphosis).

Posterior curvature of the spine, sometimes termed *cyphosis*, from the Greek word *κυφός*, "bent," is characterized by a marked convexity of the back, seated chiefly within the limits of the dorsal portion of the column, though the whole spine may participate in the distortion. The deformity is met with in both the young and the aged, and may be seen from the slightest forward inclination of the body to a degree in which the chin touches the knees. (Fig. 1530.)

Infantile posterior curvature.—Often the deformity commences in infancy in consequence of general muscular weakness. The mother carelessly allows the child to sit on her knees or in its chair, and the head falls forward and

hangs like a weight at the long end of a lever, while the spine, plastic and non-resistant, from the presence of epiphyses and from the immature stage of ossification, gradually becomes more and more bent forward, at the same time developing the curve on the back. The muscular weakness in these instances of infantile posterior curvature depends upon constitutional causes, as rachitis, syphilis, tuberculosis, etc.

Curvature of adolescence.—When the deformity arises in boys and girls, or in young adults, it is generally to be attributed to the influence of occupation, certain trades and avocations conducing more than others to the curvature, as those of shoemakers, who habitually are obliged to lean over the lapstone and the last, of tailors, who sit and bend over their work, and of clerks and students, whose lives are sedentary, and who incline forward in their respective work or studies.

Senile posterior curvature depends on diminished nutrition of the long muscles of the back, and the general impairment in the elastic structures of the spine, in consequence of which the old man leans upon the top of his staff, and his step becomes hurried, shuffling, and short, in order that he may keep up with his head, which is in advance of the rest of his body.

The condition which is commonly termed "round-shouldered" is generally due to a degree of posterior curvature at the upper part of the dorsal spine.

The pathological changes which belong to posterior spinal curvature are absorption of the anterior portions of the intervertebral cartilages and bodies of the vertebræ, thus allowing the front portions of the latter to approximate one another. As this process continues, the supra- and interspinous ligaments yield, and the spinous processes become separated and correspondingly prominent. Nature sometimes interferes to prevent the continuance of the curve, especially in subjects who possess a rheumatic diathesis, by throwing out abutments of new bone, which reach across from the body of one vertebra to that of another. The deformity of the spine extends also to the thorax and to the lumbo-sacral articulation. The ribs project posteriorly, their contiguous bodies are brought close together, and the sternum is rendered unusually prominent. The arms hang loosely in front of the body, their weight depressing the top of the shoulders, while in an equal degree it raises the inferior angles of the scapula. When the deformity includes the lumbar portion of the spine, the pelvis becomes bent towards the thorax, frequently to a degree which requires the person to walk with the legs flexed on the thighs and the latter flexed on the pelvis.

SYMPTOMS.—The signs of cyphosis are generally positive. The back exhibits a posterior curve which is formed at the expense of several vertebræ, and which is uniform and not abrupt, as in Pott's disease, the spinous processes are abnormally salient, the head and shoulders are bent forward or sunk down between the shoulders, and, when the person is required to direct the head to one side or the other, the movement is effected by the rotation of the atlas upon the axis, by which the side of the face is turned laterally and at the same time upward. In bad cases of this affection the crowded condition of the thoracic and abdominal viscera gives rise to functional disturbances of these organs, the muscles continue to waste, and walking becomes a labor.

TREATMENT.—The treatment consists in removing, as far as possible, the exciting cause of the distortion, making extension of the spine, and applying, when necessary, a mechanical support.

In fulfilling the first indication it will sometimes be necessary to address our therapeutics to the correction of some constitutional vice of the system, particularly in the case of young subjects, the remedies being some preparation of iodine, iron, or cod-liver oil, with abundance of nourishment, particularly milk.

No prolonged efforts at sitting up should be allowed, though, to a moderate extent, this posture will prove useful by inciting action in the long muscles of the back and contributing to their nutrition and strength.

Another exciting cause in older subjects, and one correctible, is to be found in the occupation or calling of the patient, and when this is of a character to aggravate the deformity it must be abandoned or exchanged for another less harmful one. It is these cases of posterior curvature in young persons which are peculiarly tractable to the principle of extension by suspension, alternated with periodical rest upon the back, together with "massage."

Mechanical support is only to be thought of in progressive cases, and in persons who, from necessity, are compelled to keep on their feet or to follow a predisposing calling; and then the best apparatus is the plaster jacket applied during suspension by the head, and, when the curve is lessened as much as possible, substituting for the plaster the leather jacket of Gemrig. (See *Pott's disease*.)

Anterior Curvature.

Anterior curvature, or *lordosis*, from the Greek word *λῑρῶς*, "bent forward," consists in an exaggerated curve of the spinal column, the convexity of which is directed anteriorly, and the concavity posteriorly. (Fig. 1531.)

Fig. 1531.



Anterior curvature, or lordosis, of the spine.

The curvature is generally confined to the lumbar and a few of the lower dorsal vertebrae, though no region of the spine is exempt. The deformity is either congenital, pathological, or acquired.

The congenital origin of the curvature is seen in those peculiarities of organization which belong to some families, and which are transmitted from parent to offspring, among which may be specified bow-legs, short-legs, and sway-backs. Congenital dislocations of the femora also give rise to a similar incurvation of the loins.

The pathological causes of the deformity are rickets, ankylosis of the coxo-femoral articulations, and disease of the lumbar vertebrae.

Acquired lordosis may be developed during gestation, also from obesity, and from ovarian tumors. The curve in these cases being wholly compensatory, and necessary to maintain the centre of gravity, it spontaneously disappears on the removal of the cause.

PATHOLOGICAL CHANGES.—When lordosis is the result of some cause of temporary duration, or one which is removable, as pregnancy, ovarian disease, or an unusual deposition of fat over the abdomen, it is not attended by any structural alterations of a serious nature; and the accommodation is secured chiefly through the normal flexibility of the spine. When, however, it is determined by conditions which are permanent, the vertebrae undergo changes the reverse of those observed in anterior curvature or cypophosis; that is to say, the pedicles are bent downward; the articulating processes, instead of being directed outward and backward, are changed so as to look backward and downward; the spinous processes are increasingly curved downward and flattened, in consequence of being crowded against one another; the anterior common vertebral ligament is elongated; the bodies of the vertebrae are diminished posteriorly in their vertical diameters, while anteriorly they are separated, the interspaces being filled by the expansion of the intervertebral cartilages.

SYMPTOMS.—The symptoms of anterior curvature vary with the regions of the spine affected. As the pedicles yield, in bad cases of the disease, the nerves which pass through the intervertebral foramina are encroached upon, and then follows, if the depravity is limited to the lumbar region, a flabby

state of the abdominal muscles, accompanied with flatulent distention of the intestines, and pain in the course of the spinal muscles.

When the lumbo-dorsal portion of the column is the seat of the distortion, there exists posteriorly a deep concavity corresponding to this part of the spine; the abdomen becomes very prominent, the upper part of the trunk is thrown back, and the head is carried somewhat forward. This posture necessarily produces a change in the lumbo-sacral angle, causing a depression of the pubes and ilia, and an elevation of the ischia and sacrum, giving to the hips an unusual prominence. The influence of these changes on the locomotion of the individual is very characteristic. The lower limbs are not advanced in a steady, direct manner, but, considerably separated, are hitched forward with a sudden, jerking movement, during which the body at the same time rocks from side to side.

When lordosis affects the dorsal region, it is probably secondary to caries of some part of the spine above or below the curve,—that is, in the cervical or the dorso-lumbar region,—and is a compensation for the irregular curvature. The effect of the simultaneous presence of the two affections is to impart greater saliency to the angular prominence, and to cause an increased concavity posteriorly above and below the latter.

Rotatory lateral curvature of the spine is sometimes seen associated with dorsal lordosis, the latter condition usually preceding the former.

When the curvature is dorsal, pleurodynia and oppression of breathing may follow, or, if it is seated in the cervical region, there may be disturbances both of the organs of circulation and of respiration, with numbness and neuralgic pains in the arms.

When the anterior curvature affects the cervical division of the spine, it is the sequel to caries of the same region at a lower point. The head is thrown back, and, the face being turned upward, the anterior portion of the neck is lengthened, the larynx prominent, and, in the event of reparation taking place in the diseased vertebræ, the malposition of the head may remain permanent.

TREATMENT.—Lordosis in a considerable proportion of cases requires no surgical interference. In those cases which arise from conditions that are of temporary duration, the curvature will disappear spontaneously on the removal of the excitant; and in those which are due to hereditary or pathological causation, the deformity is a necessity, or an adjustment of the skeleton to extraordinary or unusual conditions, salutary rather than harmful, and, therefore, equally without the pale of mechanical and of medicinal therapeutics.

An exception to this general statement can be properly made when the lordosis exists along with caries of the vertebræ, in whatever region it may occur. Here artificial support becomes necessary; but the appliances used for that purpose need not differ from those ordinarily employed in the management of caries or Pott's disease of the spine, described in detail under the head of the latter affection.

Constitutional treatment is not to be discarded when the indications for its employment are present, in which event the appropriate remedies will not differ from those suited to a case of lateral curvature.

Posterior Angular Curvature.—Pott's Disease.

Posterior angular curvature is the result of inflammatory destruction of a number of vertebræ, together with their intervertebral cartilages.

It is an exceedingly common disease, often followed by lamentable deformity. As with coxalgia, it is too frequently the case that the disease is allowed to make considerable progress before the suspicions of the medical attendant are awakened or his attention is directed to the spinal column. To Percival Pott the profession is indebted for a correct exposition of the pathology and treatment of the disease.

Posterior angular curvature occurs with nearly equal frequency in both sexes. No time of life, from the intra-uterine to old age, is exempt from the ravages of the disease, though the period between two and a half and ten years of age, when the developmental forces are most active in the spine, embraces by far the largest number of cases. It affects both the rich and the poor, though in our great cities the latter class suffer oftener from the disease than the former. I do not believe it is more commonly met with among the inhabitants of cities than among those of the country.

While any region of the spine may be the seat of the disease, its very common location in the dorsal section of the column is a matter of general observation, but which has not as yet been definitely explained. The question as to the cause of the localization of the disease may with equal pertinence be asked in regard to coxalgia and knee-joint disease. We naturally look for a solution of the problem from anatomical and physiological considerations, or such as grow out of structure and function. The dorsal portion of the spine is unquestionably, from its length and mobility, more vulnerable to traumatic agencies than either the cervical or the lumbar, and this fact may be sufficient to explain the election of this part of the column by the disease. In rare instances a single vertebra is affected, though commonly two or three are finally involved. Occasionally separate regions of the spine are simultaneously attacked.

CAUSES.—The disease may begin either in the intervertebral fibro-cartilages or in the bodies of the vertebrae, much in the same manner as inflammatory affections of the joints may commence primarily in the articulating cartilage or in the ends of the contiguous bones. The relative frequency with which the cartilages or the bodies of the vertebrae take precedence in the attack is not positively known, as the opportunities for making examinations in the incipient stage of the disease are rare. I am disposed to believe that in a large majority of cases the vertebrae are first affected, and that the cartilages subsequently disintegrate from the destructive effects of the contiguous inflammation.

The bodies of the vertebrae consist almost wholly of cancellated tissue included in a thin film of compact bone covered by periosteum and in front by fibres of the anterior common vertebral ligament. Each piece is remarkably independent of its neighbor, having its own arterial and venous system; consequently the vascular communication which exists between the different vertebrae is in the main through the periosteum.

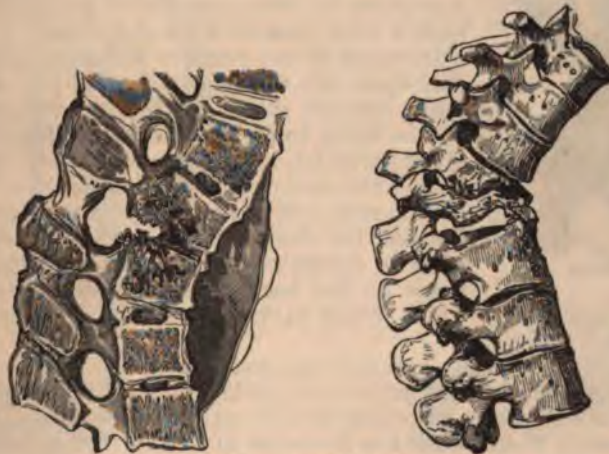
Two classes of causes are accredited with producing the disease,—constitutional and traumatic. Those who refer it to the former believe that the prime factor in the morbid process is a strumous or tubercular state of the general system, and that the spinal disease is only a local manifestation of such a vice. Other surgeons, who espouse the traumatic theory, believe that the inflammation which affects the vertebrae is in no way peculiar, and is due to twists, strains, blows, concussions, etc., of the vertebral column.

There are certain forcible objections to be urged against the traumatic theory. How are we to explain those cases of posterior angular curvature which appear long before the child is exposed to any external violence whatever, and when, from its tender age and the constant watchfulness inspired by maternal affection, it is altogether improbable that any accident of the kind could have occurred? Again, why does it happen that the subjects of this disease, as a class, are not at all remarkable for that irrepressible activity and daring which expose young boys and girls to accidents and injuries? On the contrary, according to my observation, the children who suffer from Pott's disease are given to a more quiet, retiring, and thoughtful mode of passing time. Again, if traumatism is a sufficient explanation for Pott's disease, how are we to account for the fact that boys and girls suffer with about equal frequency, when it is well known that the former, from the nature of their amusements, are much more exposed to casualties than

the latter? And, finally, does not the history of cases of posterior angular curvature almost uniformly reveal an antecedent tubercular or strumous ancestry? At least such has been the result of my inquiries; and I am, therefore, not disposed to adopt the views entertained by some modern writers, until the knife and the glass of the pathologist furnish me something more satisfactory than speculation. As far as I am capable of judging, the disease commences by an infiltration or a disseminated formation of strumous or of tubercular matter in the cancellated tissue of one or more vertebræ. It does not follow that, coincident with such deposition, the active signs of the disease must appear; on the contrary, the formation may remain quiescent for many months, just as a cheesy lymphatic gland of the neck or a little mass of tuberculous granulations in the lung may repose quietly for a considerable period before softening or the work of destruction begins. A time, however, does arrive when some depreciation in the health, or some injury (and here is where traumatism comes in), kindles into activity the inflammatory processes or osteitis, as the match when applied to the fuse explodes the charge of powder, which until then had lain quiet, giving no evidence of its tremendous capacity for evil. It is probable that in most cases of Pott's disease there is both a specific and a common inflammation at work, the former beginning in a tuberculous vertebra and losing its specific character as it extends to the bodies of adjoining vertebræ which may have been entirely free from the original disease.

Structural alterations.—As the cartilages disintegrate and disappear, and the bodies of the diseased vertebræ are destroyed by the inflammation in the periosteum, the superincumbent weight of the body, conjoined with muscular action, crumbles down the disorganized osseous tissue, while the bodies of those vertebræ above and below the diseased ones approach each other. As the arches and the articular spinous processes are not implicated in the devastation, the column still retains its lateral and posterior abutments, and as the centre of gravity, by the change in the bodies of the diseased vertebræ, falls somewhat in advance of the normal line, the spine yields, pushing out a posterior projection, the size of which will depend on the number of vertebræ destroyed. With the formation of this posterior angular curvature there occurs an unusual pressure in front, formed by the sternum and the

FIG. 1532.



Vertebræ excavated by caries.

ribs, the latter being crowded closely together at the vertebral extremities when the disease is situated in the dorsal part of the column.

As the diseased vertebræ crumble away under the destructive osteitis and the adjoining ones fall together, the nerves are liable to suffer compression, although it is one of the marvels of this disease that seldom is any very serious injury sustained by the cord or its meninges or nerves, even though the disorganization may extend to several vertebræ and the resulting deformity be very great.

Sometimes the disease appears to be limited to the epiphyses of the bones and the intervening fibro-cartilages, without invading the bodies of the vertebræ, while at other times the cancelli of the bones present a gnawed, irregular, excavated appearance, the exterior shell of compact tissue still remaining. (Fig. 1532.)

As regards the amount of suppuration, there is nothing uniform. The pus may be small in amount, undergo a retrograde metamorphosis, and be removed by the absorbents, or it may undergo a cheesy, cretaceous transformation, and remain indefinitely in the midst of the ruin of the disorganized vertebræ, or in contact with the reparative material, in which state it may prove a source of future mischief by provoking secondary abscesses. In other instances the suppuration may be profuse, forming collections between the bones and the thickened periosteum.

Spinal Abscesses.—The direction and termination of spinal abscesses will be determined by the region of the spine affected. When the caries is located in the lumbar portion of the spine the pus may enter the sheath of the psoas magnus muscle, and finally reach the thigh, passing into the latter beneath Poupart's ligament and external to the femoral blood-vessels, forming a "psoas abscess" (Fig. 1533); or it may find its way between the fascia of the

quadratus lumborum and abdominal muscles, and open on the outer border of the erector spinæ muscle, constituting lumbar abscess, or may appear more anteriorly above Poupart's ligament, or, again, it may burrow beneath the internal iliac muscles, and pass over the brim of the pelvis, through the great sacro-sciatic foramen, and appear in the gluteal region as a gluteal abscess.

When the dorsal region is the seat of the disease, purulent collections frequently form between the bones and their thickened periosteum, or the pus may work its way posteriorly and appear on the back a short distance from the spine.

In caries of the cervical vertebræ, spinal abscess may open into the pharynx, or, if the resistance of tissue compels the pus to find its way externally, it will be likely to do so between the longus colli and scaleni muscles, and appear on the side of the neck behind the sterno-cleido-mastoid muscle.

SYMPTOMS.—It is a matter of great consequence to discover the disease at the earliest possible period. If it is recognized only when the deformity appears on the back, much valuable time has been

lost, the proper use of which would have been of vital importance to the patient.

Long before there is any external manifestation of the disease there exist a number of subjective signs which are quickly detected by a sagacious physician. These signs differ according to the location of the disease; the earliest are those which result from the irritation of certain spinal nerves where they leave the intervertebral foramina, the effect of which is transmitted to their peripheral branches.

When disease begins in the lumbar region, the patient often complains of colicky pains in the abdomen having a flatulent origin, and not unfrequently

FIG. 1533.



Psoas abscess.

is found to assume some unusual position when in bed, sometimes on his breast, sometimes on the hands and knees. Irritation of the bladder, attended with frequent urination, and sometimes incontinence of urine, together with darting pains above the thighs, are also among the early phenomena which betray the disease when seated in the lower part of the spine. When the dorsal region of the column is invaded, in addition to the symptoms of gastric irritation there are intercostal pains, a feeling frequently of constriction about the body, and possibly some little discomfort about the chest. The respiration is often carried on in a short, grunting manner, the power of the respiratory muscles being diverted, if the expression may be allowed, from the movement of the chest to aid in fixing the spine.

Should the cervical region suffer, there may be difficulty of deglutition, choreic movements of the muscles of the neck, tingling and numbness of the arms, or an irritating laryngeal cough.

In whatever part of the spine the disease is situated, the behavior of the child will be changed. If, in moments of play, the little patient should jump from a chair or sofa upon the floor, the concussion communicated to the spine produces a momentary confusion of thought; he staggers, looks surprised, and possibly falls. He is soon tired at his play, and is disposed to lie down or to lean over the nearest object for support, with one limb crossed over its fellow. As the disease progresses, the movements of the patient become restricted and artificial; every muscle is engaged in immobilizing the spine and relieving it from the superincumbent pressure. If the child sits, the hands are placed on the thighs, in order to take off the weight of the shoulders from the column. In standing, the head is thrown back, the shoulders are raised by the trapezii muscles, the arms allowed to hang by the sides, with the palms of the hands directed backward, and the feet turned out. (Fig. 1534.) In walking, the same posture is maintained, but the feet, instead

FIG. 1534.



Standing position in Pott's disease.

FIG. 1535.



Manner of picking up an object in Pott's disease.

of being raised and put down with confidence or indifference, are shuffled along with a studied care. At other times he will move only by reaching

with his hands from one article of furniture to another. When he wishes to pick up any object, instead of bending forward, as in health, the little patient will squat down by flexing the legs and the thighs, and reach for the object, while the body is kept rigidly straight (Fig. 1535), and he will rise in the same careful manner observed in stooping.

The presence of such phenomena will at once suggest a careful investigation of the spine. In conducting this part of the examination, the child must be divested of its clothing, and either made to stand with the trunk slightly bent forward, or be placed across the knees of the surgeon. Frequently an unusual prominence of one or more spinous processes will be detected as the earliest external manifestation of the commencing posterior angular curve, indicating that the destruction of the implicated vertebræ is in progress. While in the positions already described, the spine may be further tested by extension and by pressure. If one hand is placed over the back and the other over the front of the head, and the child is partially raised from the floor, or if the limbs across which the child lies are separated, the elongation or stretching of the column thus produced will be followed by a sudden amelioration of all the symptoms; while if the vertebræ are crowded together by simultaneous pressure made at the extremities of the spine, there will be an aggravation of suffering, spasmodic movements of certain muscles, with probably a cry or some other sign of uneasiness extorted from the patient. Little is to be learned from tapping or percussing the spinous processes in order to develop tenderness or pain over the affected vertebræ: the vibrations do not reach the bodies of the bones, but are expended on the arches and other processes. Lateral pressure applied to the ribs will sometimes develop pain when percussion over the spinous processes gives a negative result, because the ribs are directly articulated with the bodies of the vertebræ and the intervertebral cartilages.

In well-marked cases of Pott's disease the angular curvature on the back is very prominent. (Fig. 1536.) When the disorganization and displacement

FIG. 1536.



Angular projection of the spine.

are great, the spinal cord and nerves are exposed to pressure which sometimes is sufficient to interrupt the transmission of the nervous power, and, when the disease is in the lower dorsal and lumbar regions, will occasion paralysis of the lower extremities, and of the bladder and rectum.

Inflammation of the meninges of the cord is occasionally provoked by the irritation to which the membranes are exposed. The irresistible tendency to keep the feet in motion which is often seen in children suffering from the disease may generally be interpreted as an evidence of meningeal irritation; and to the same cause may be ascribed many of those eccentric surface sensations which are experienced, as formication and localized hyperæsthesia.

As the local disease advances, the general system begins to suffer. The child loses flesh, the muscles waste, the face becomes pale and sickly, the appetite fails, all youthful vivacity disappears, and the child either becomes fretful and capricious in temper, or assumes a quiet, sober, pensive air far in advance of its years.

DIAGNOSIS.—Pott's disease may be mistaken for rheumatism, neuralgia, aneurism of the thoracic or of the abdominal aorta, chronic disease of the kidneys, abscess, superficial spinal caries, and emotional or hysterical disease.

When the affection has advanced to the stage in which the spinous processes

project posteriorly, forming the angular curvature, there can of course be no difficulty in recognizing the nature of the disease. The uncertainty or obscurity of diagnosis is limited to the initial stage.

In investigating a case of supposed Pott's disease, we may generally distinguish it from the above-named diseases and arrive at a correct conclusion by attending to the following considerations:

Rheumatism.—Rheumatism of the spine in children is very uncommon, and when it does exist the attack is sudden, the pain or uneasiness is not limited to a very circumscribed area, but is diffused, does not materially affect the movements of the patient, and is not relieved by extension of the spine. Contrast this group of symptoms with those which characterize posterior angular curvature,—by no means an uncommon disease,—its slow approach, the localized pain, the general disability of the spine exhibited in almost every movement, and the immediate relief from all discomfort on stretching the column, and it is not probable that the error of confounding the two diseases will be committed.

Neuralgia.—In intercostal neuralgia, independent of spinal caries, the pain is intermittent, while in spinal caries it is constant; again, if the vertebræ are crowded together the pain in neuralgia is not aggravated, but is so in actual disease of the spine.

Aneurism.—Thoracic and abdominal aneurism are diseases of adult life, and may be excluded from the category of affections which complicate the diagnosis of infantile disease of the spine, but must be entertained when we come to differentiate spinal disease in adults.

The throb of the aorta, resting as it does against the spinal column, will, when it undergoes aneurismal dilatation, occasion absorption and caries of the vertebræ with which the tumor is in contact. The pain, too, is local, and, as the bones are worn, there may follow a slight projection in the dorsal region. There are, however, notable distinctions between the two diseases. Aneurism may be developed in persons whose antecedent history reveals no hereditary vice. Rarely is this the case with adult subjects of angular curvature. A careful inquiry will usually reveal the fact that one of the parents, or a brother or sister, has died of consumption or cancer, and that the individual himself, when young, had been the subject of glandular enlargements of the neck. As many members of the profession attach great importance to syphilis as a cause of aneurism, the state of the patient in this respect would legitimately enter into the inquiry. Again, the movements of the patients in the two affections are entirely dissimilar. There is never in aneurism that fixed state of the entire spine which tells in the walk, as in every other motion, of persons with true Pott's disease. With these differential signs may be contrasted the infrequency of any angular curvature in aneurism and its constancy in primary spinal caries; and, lastly, the existence often of characteristic sounds in aneurism which are never present in angular curvature.

Disease of the kidneys.—Chronic disease of the kidneys, which is often accompanied with pain in the back, can generally be recognized by an examination of the urine.

Abscess.—The most difficult task is to distinguish those abscesses which sometimes form in the course of the spine, and which are in no way dependent on inflammatory disease of the vertebræ, from those which accompany Pott's disease. We say that abscesses dependent on disease of the bodies of the spine generally point in the groin, either above or below Poupart's ligament, or in the lumbar region; but, while this is true, there are others which appear in the same localities wholly unconnected with any bone disease whatever, as those which originate in the cellular tissue about the kidney,—perinephritic,—or around the head of the colon,—pericæcal,—or in the iliac fossæ, or in the lumbar glands, or even in the cavity of the thorax,—empyemic. If the abscess has a perinephritic origin, it will be likely to point in the lumbar region, and will be accompanied by signs of renal disturbance; if pericæcal,

the abscess will be limited to the right side, and will be attended with deep-seated iliac pain on pressure, and with intestinal symptoms.

Iliac and psoas abscesses, when disconnected with bone disease, as a rule, arise from traumatic causes and develop with considerable rapidity. Indeed, in all abscesses situated within the abdomen and in the neighborhood of the spine, and not dependent on actual disease of the latter, the symptoms are more acute, the chills more pronounced, the fever partakes more of the continued than of the hectic type, and the pus is more healthy than when associated with spinal disease; to which may be added the fact that they are unattended with any spinal deformity corresponding to posterior angular curvature.

Empyema.—In those rare instances in which a purulent collection finds its way beneath the arcuate ligaments of the diaphragm and along the psoas muscle to the groin, there has been an antecedent history of pleuritis or pleuro-pneumonia.

Superficial spinal caries.—There is a form of spinal caries altogether distinct from Pott's disease, but which is liable to be confounded with the latter, in consequence of the location of the accompanying pain and the existence of abscess. This variety of caries is occasioned by cold or by sprain, and sometimes by constitutional causes; it commences as a periostitis, affects two or three vertebræ at the same time, shows little tendency to penetrate deeply, and is not attended with angular curvature. The progress of the disease is slow, and its termination in the adult usually fatal, the patient dying from exhaustion. Young subjects may recover.

Emotional imitations of spinal disease, or those which relate to the will, may be detected by attending to the following facts. There is no evidence that the functions of the cord are materially interfered with, inasmuch as the nutrition and the reflex actions remain undisturbed. The phenomena are to be referred to the brain rather than to the medulla spinalis. They appear and disappear suddenly, and often under some mental excitement; the subjects are persons who exhibit other evidences of being emotional, and who are of an age at which the ideal dominates the real; and, finally, these mimicries are strengthened by the very notice which they attract.

Prognosis.—Posterior angular curvature is always to be regarded as a serious disease. There are two things to be considered in the prognosis, namely, the amount of deformity, and the life of the patient.

With reference to the deformity, much will depend on the constitutional condition of the subject, the early recognition of the disease, and the character of the treatment; but, even when all these are in favor of the patient, less or more deformity will exist, and this never can be corrected.

Life, however, is not seriously imperiled by the disease. Many persons with curved spines are seen in every sphere of life, well advanced in years, and capable of laborious occupation. Few children who receive proper care perish from angular curvature. Of those whose cases I have been able to follow I recall only two who have died from causes directly traceable to the spinal affection. In one of these the mother, in opposition to strict instructions to the contrary, allowed the child on several occasions to walk across the room without the accustomed support. This he did with great difficulty, and in one of these attempts the little fellow suddenly doubled up, fell on the floor, became paraplegic, and died in a convulsion. In forming a prognosis the locality of the disease must be considered, the most favorable cases being those in which the affection is situated in the lumbar or dorsal region. When the disease attacks the cervical portion of the spine, the danger to life is greatly increased. This arises sometimes in consequence of the formation of abscesses which open into the pharynx or into the spinal canal and compress the cord. Life is also in danger of being suddenly destroyed by displacements of the vertebræ, due either to destruction of their bodies or to rupture of the transverse ligament.

Nothing renders the prognosis more unfavorable than the existence of

abscess. Many cases of this form of spine disease pass through every stage without any external evidences of abscess; and it is not an overstatement to say that more children perish from abscesses which open internally than from all other causes combined. Under any circumstances, recovery from Pott's disease is a slow process, requiring in most instances from three to ten years for its completion.

REPAIR.—The repair of the damaged portion of the spine is by ankylosis, and this may commence in one part while the disease is in progress in another. There is a remarkable provision of nature witnessed in the plan or order of this repair. While the destructive process is going on in the bodies of the vertebræ, there occur an inflammatory thickening and agglutination of the soft tissues around the seat of disease, in order, it would seem, to erect a barrier which shall separate the diseased from the adjacent sound tissues. The periosteum covering the arches and processes participates in this general activity, and, in virtue of its osteogenetic property, unites all together by bridges and columns of bones. This consolidation of the posterior appendages of the affected vertebræ may lessen the angular curvature by preventing the bodies of those vertebræ which are outside of the limits of disease from approaching each other, though it will certainly render the patient less secure than when, in addition to the osseous union of the arches and processes, the chasm or gap between the bodies is diminished sufficiently to be also spanned by bridges of bone.

Considerable angular curvature, therefore, while it greatly mars the beauty of the form, compensates for the deformity by making the consolidation of the column more secure. In all these reparative processes the cord is not encroached upon, and the intervertebral foramina for the passage of the spinal nerves are preserved.

TREATMENT.—In the treatment of Pott's disease both general and local measures are to be employed. The former include the use of all those remedies which tend to improve the blood and strengthen the constitution, and which co-operate with natural processes in eliminating the diathesis on which the disease depends. For these ends cod-liver oil, the iodide of iron, and the phosphates, together with a nutritious food and fresh country air, are the most important. The local treatment is even more valuable than the constitutional, as without this the former can accomplish little good.

If the disease develops before the child is able to walk, rest in the recumbent position is imperative. The little patient can be laid upon a pillow or on a sacking-bed, which, sinking somewhat in the middle, will prevent the child from turning upon the side. When the circumstances of the parents will permit, an air-bed is to be preferred. During pleasant days the bed can be placed upon wheels and pulled into the open air. By maintaining the horizontal position the spine is relieved of the weight of the body and the traction of the muscles, and by its being preserved in a fixed state of rest several very potential excitants to inflammation are avoided. How long this enforced rest is to be kept up must be determined by the locality of the disease. When the disease is seated in the cervical or cervico-dorsal region, the only period I would fix would be that at which ankylosis was established and the child well, as no apparatus ever devised by the ingenuity of man can sufficiently relieve the spine from the weight of the head to render the erect position safe. When the disease makes its appearance in a child who has for some time been moving about, whether seated in the lumbar or in the dorsal region, it would be well if the horizontal position could be enforced for at least six or eight months. This, however, is not always feasible.

There are circumstances inseparable from social life which make it necessary that the patient should be as little dependent as possible, and it is sometimes necessary, in order to rescue him from the designs of irregular charlatans, that he should be placed on his feet at the earliest possible moment.

When the disease, therefore, is seated in the lumbar vertebrae, or not above the fifth dorsal vertebra, a mechanical appliance can be adjusted which will afford an excellent support to the spine, and by wearing which the cure may progress without any very serious drawback. Most of the appliances which have been in use for this purpose propose to relieve the spine of the superincumbent weight by crutches placed under the arms and fastened below to a padded band of metal, thus distributing the weight of the shoulder over the hip and the sacrum. This form of apparatus is secured to the person by a laced corset, or by buckles and straps. (See Fig. 1529.) That such a mechanism imparts some security to the spine is doubtless true, but that it is far from meeting the true necessities of the case must be apparent to any one at all familiar with spinal physics. When the disease is seated high up in the dorsal region a head-support is necessary, and one can be attached to the jacket (Fig. 1537), which is susceptible of being raised or lowered at pleasure,

and which lessens the weight to be borne by the spine, as from this support the head is suspended by chin and occipital bands. (Fig. 1538.)

To Professor Sayre, of New York, the profession is indebted for the most important dressing in the treatment of this form of spinal disease, and for the discovery of which humanity owes him a debt of everlasting gratitude. It is valuable alike for its efficiency and its simplicity.

The plaster dressing to which I refer is applied in the following manner. The child is divested of its clothing and fitted with a knit woolen shirt extending a short distance below the hips and without sleeves, in lieu of which two straps of the same material are pinned or tied over the shoulders. This shirt



Fig. 1537.
Spinal jacket with head-support.

Fig. 1538.
Suspension apparatus applied.

must adapt itself so accurately to the figure of the patient that there shall be no creases. The child is now placed under a tripod, or a beam, to which are attached a compound pulley and a leather head-gear. (Fig. 1539.) The pulley being lowered and the apparatus designed to embrace the occiput and the chin adjusted, the child is raised by drawing upon the cord until the toes barely touch the floor. (Fig. 1540.)

The extension is made directly on the spine, and, while this is kept up, the surgeon takes a plaster roller two and a half inches wide and from five to seven yards long, and, soaking it for two minutes in a basin of water and then squeezing the redundant fluid well through its pores, makes one or two turns round the pelvis, between the trochanters and the crests of the ilii, continuing its application regularly up to the axillæ, each turn overlapping the preceding about one-third. Three or four additional rollers are applied in the same way, observing to smooth the plaster by passing the dry hand frequently over the surface of the roller.

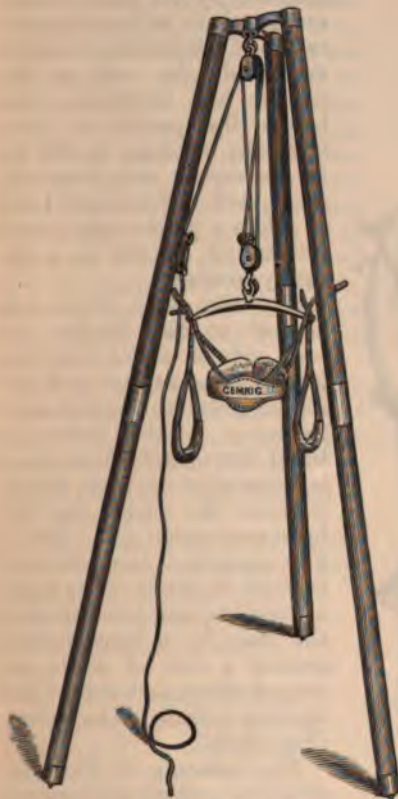
In ten minutes the plaster will have become sufficiently hard to admit of the child being taken under the arms and, after the head-gear is unbuckled, laid at full length upon a hard mattress, in which position he should remain for from three-quarters of an hour to an hour, after which the clothing may be put on and he may be allowed to go about.

By this plan the body is encased in a hard shell or coat of mail which fits into every inequality of the surface and thus distributes the support over an extended superficies. If desired, the plaster can now be sawed or slit up in front with cutting pliers, and its edges bound with leather having holes and

studs so as to be laced up in front. The support for the arms can be made comfortable either by introducing crutches between the layers of the bandage or by turning over the upper turns of the bandage so as to give the sub-

FIG. 1540.

FIG. 1539.



Suspension apparatus.



Child suspended.

axillary portion of the dressing a rounded form. This must be done before the plaster hardens.

As it is of great importance that the weight of the head should also be taken off the spine, a head-support should be in readiness to make fast to the plaster apparel. This is formed of two parts, a back-piece and a head-piece, the first consisting of a plate of steel containing a socket with a button-headed screw, and two pieces of strap-iron perforated with holes; the second, a rod of steel fashioned at its lower end so as to drop into the socket, and bent so as to conform to the back of the neck and the head, above which it must extend, and having fastened to its extremity a swivel and head-gear. (Fig. 1541.) The back-piece of this suspension apparatus is secured between the layers of the plaster bandage, being applied between the first two and the last rollers. The head part is adjusted subsequently while the patient is standing, by introducing its rounded extremity into the socket, arranging the head-gear under the chin and the occiput, and then raising it until the proper degree of support is obtained, when, by turning the button-headed screw, the support is fixed in position.

Mr. Gemrig, one of the prominent surgical cutlers of Philadelphia, has constructed from half-tanned leather a spinal jacket which I find to answer the purpose of support quite as well as plaster, and which is very much

FIG. 1542.



lighter and far more durable. In forming this leather jacket the child is clad in a knit shirt and suspended from the tripod and surrounded by the plaster rollers, precisely as in the application of the dressing already described. As soon as the plaster has hardened, and before the patient is lowered, the bandage is slit up in the centre and removed. (Fig. 1542.) From this shell is taken a plaster cast, over which the leather is accurately moulded.

One thin strip of steel is riveted to the leather on each side in a line running between the armpit and the hip, in order to prevent any tendency in the jacket to break down, and a thin piece is fastened to the back, which contains the socket for the head-suspension. (Fig. 1543.) The apparatus is perforated in order to render it as light as possible, and is secured to the body by a lacer passed around a row of studs arranged along each side of the opening in front of the jacket. (Fig. 1544.)

Mr. Johnson, of Philadelphia, has constructed a spinal jacket of felt, a mould being first procured by taking a plaster cast of the trunk. (Fig. 1545.) In two instances where I tried the felt apparatus, however, it failed to answer the purpose.



FIG. 1541.

Apparatus for supporting the head.

Plaster applied and slit up in order to prepare plaster cast.

When ankylosis has taken place and the column has become consolidated about the seat of the disease, which may be known by a permanent arrest of the angular excavation and by the firmness of the ankylosed parts, the jacket should be gradually withdrawn, at first for half an hour every day, lengthening the period by degrees, until it can, in the course of four or five months, be dispensed with entirely. The muscles of the back in the meantime should be treated by "massage," in order to improve their nutrition and strength.

The various local applications which have been employed at different times, as setons, issues, the cautery, blisters, iodine, and various irritants, are many of them positively injurious, and from the use of even the mildest of these agents I have never seen any positive benefit result.

COMPLICATIONS.—Among the complications which attend posterior angular curvature of the spine are abscess and hip-joint disease, or coxalgia.

Spinal abscess is more to be dreaded than any other complication of angular curvature, except, perhaps, destructive lesion of the cord. I have already stated that it is the principal cause of death in Pott's disease. Abscesses which open posteriorly in the dorsal region—much the less common form—are not so serious in their consequences as those which follow the bodies of the vertebræ and become finally visible at a point remote from their origin, because the place where they point is near the seat of disease, and they do not, consequently, attain the same magnitude or cause the same destruction of tissue as the latter.

All of these abscesses, except those originating in the cervical part of the column, naturally seek an outlet in the direction of the inguinal, iliac, lumbar, or gluteal region.

There are two reasons for this,—a physical and an anatomical one,—viz., the influence of gravity, and the peculiarities of structure.

Cervical abscess.—When the caries involves the vertebræ of the neck, terminating in suppuration, the abscess will proceed in one of two directions, either anteriorly, the tumor presenting behind the posterior wall of the pharynx, or posterolaterally, the pus dissecting its way between the longus colli and the scaleni muscles, and reaching the external surface of the neck posterior to the sterno-cleido-mastoid muscle, turning the head to the opposite side.

There is a retro-pharyngeal abscess which commences in the cellular tissue between the pharynx and the periosteum of the cervical vertebræ which might be confounded with spinal abscess



FIG. 1545.



Johnson's felt jacket applied.

Mr. Gemrig, one of the prominent surgical cutlers of Philadelphia, has constructed from half-tanned leather a spinal jacket which I find to answer the purpose of support quite as well as plaster, and which is very much

lighter and far more durable. In forming this leather jacket the child is clad in a knit shirt and suspended from the tripod and surrounded by the plaster rollers, precisely as in the application of the dressing already described. As soon as the plaster has hardened, and before the patient is lowered, the bandage is slit up in the centre and removed. (Fig. 1542.) From this shell is taken a plaster cast, over which the leather is accurately moulded.

One thin strip of steel is riveted to the leather on each side in a line running between the armpit and the hip, in order to prevent any tendency in the jacket to break down, and a thin piece is fastened to the back, which contains the socket for the head-suspension. (Fig. 1543.) The apparatus is perforated in order to render it as light as possible, and is secured to the body by a lacer passed around a row of studs arranged along each side of the opening in front of the jacket. (Fig. 1544.)

Mr. Johnson, of Philadelphia, has constructed a spinal jacket of felt, a mould being first procured by taking a plaster cast of the trunk. (Fig. 1545.) In two instances where I tried the felt apparatus, however, it failed to answer the purpose.

When ankylosis has taken place and the column has become consolidated about the seat of the disease, which may be known by a permanent arrest of the angular excavation and by the firmness of the ankylosed parts, the jacket should be gradually withdrawn, at first for half an hour every day, lengthening the period by degrees, until it can, in the course of four or five months, be dispensed with entirely. The muscles of the back in the mean time should be treated by "massage," in order to improve their nutrition and strength.

The various local applications which have been employed at different times, as setons, issues, the cautery, blisters, iodine, and various irritants, are many of them positively injurious, and from the use of even the mildest of these agents I have never seen any positive benefit result.

FIG. 1542.



FIG. 1541.



Apparatus for supporting the head.

Plaster applied and slit up in order to prepare plaster cast.

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subsequent hectic correspondingly lessened in severity. Often, however, the surgeon does not meet with this happy combination of conditions: he must, of course, be prepared to treat the case as it commonly presents itself, and decide accordingly. Under these circumstances it is best not to delay, but to proceed at once to lay open the abscess. The operation should be done with the bistoury. If the patient grows weak and faint before the whole amount is evacuated, the tapping may be suspended, to be repeated at a future time; but, unless such a necessity exists, I prefer, after removing the pus, to wash out the cavity with sublimated water, introduce at once a drainage-tube, and dress antiseptically. The constant withdrawal of the purulent contents by this plan favors the gradual collapse of the walls of the sac and diminishes its vascularity. It is true that in many instances the walls of the abscess are adherent to surrounding parts which will not yield, and this collapse is thereby prevented; but this condition may affect only a portion of the sac, and therefore the treatment will not be useless.

Should the abscess communicate directly with the affected vertebra, the surgeon will sometimes have it in his power not only to lessen the supuration, but also to hasten the repair of bone by scraping away such dead portions as may be accessible.

In cases of paralysis following Pott's disease, especially when coming on suddenly, thereby indicating pressure of the cord by bony displacement, it is possible by the use of the trephine, or by cutting pliers, to remove a part of the lamina and cure the paralysis. Macewen has had at least four successful operations of this kind.

When feasible, as in iliac and lumbar abscess, pressure may be superadded, which will conduce to the same end,—that of diminishing the purulent cavity.

Traumatic psoas, iliac, and lumbar abscesses should be opened as soon as discovered. They may be distinguished from those which are dependent on spinal disease by the previous general good health of the patient, by the symptoms coming on suddenly after a sufficient injury, and by the laudable character of the pus.

I attended with Dr. Morehouse, of Philadelphia, a patient who, on attempting to raise a piano while in the stooping posture, felt severe and sudden pain within the body, accompanied with weakness of the back. The accident was followed by continuous suffering in the loins, a flexed condition of the thigh, and fever. It was our united opinion that a few fibres of the psoas

muscle had been ruptured, and that probably an abscess would be the result. In a few weeks this proved to be the case, the abscess presenting between Poupart's ligament and the thigh, when it was opened, after which the patient completely recovered.

I have seen iliac and lumbar abscesses arising from similar causes, and terminating, after their discharge, in a like happy manner.

In cases where disease of the spine is complicated by the development of coxalgia, the patient, if old enough to walk, may wear without difficulty both the apparatus for angular curvature and that for hip-joint disease, as shown in Fig. 1546.

FIG. 1546.



MALFORMATIONS OF THE HEAD FROM EFFUSION.

The malformations of the head are congenital, and in almost every instance are determined by dropsy of the ventricles of the brain. When the accumulation of fluid, by its centrifugal pressure, expands the cerebrum until it becomes a thin shell of neurine, the disease is termed *hydrocephalus internus*. When the brain-substance, under the same pressure, yields in a particular direction, and is forced through one of the sutures, forming an external tumor, it is called an *encephalocele*. When the medullary and cortical neurine give way, in consequence of the increase of ventricular fluid, and the membranes or meninges are pushed through between the cranial bones to the outside of the skull, the disease is called a *meningocele*; and should the swelling consist of brain-matter and a fluid between the latter and the membranes, it will form an *encephalo-meningocele*. The pathology of congenital ventricular dropsy has not been satisfactorily determined. The disease probably begins in the choroid plexuses, but whether it is inflammatory or not it is difficult to say.

Hydrocephalus Internus.—This disease is one of intra-uterine life, and in cases where it is thought to have commenced after birth I do not doubt that a close scrutiny would have revealed some evidence of its pre-existence. The fluid of hydrocephalus is slightly saline, and may be regarded as an exceedingly dilute cerebro-spinal liquid, modified in some degree by chronic inflammation. The disease, as has been stated, commences in the ventricles, and as the fluid continues to increase the brain is expanded, and at the same time the cranial bones become separated from one another by the outward pressure. (Fig. 1547.) The effect of this centrifugal force is to increase the extent of the membrane which occupies the space between the different pieces of the cranium, to enlarge the fontanel, and also to diminish the thickness of the bones. The coronal suture appears to yield most readily, so that the antero-posterior or occipito-frontal diameter is most increased: this enlargement, the expansion of the head in other directions, the prominent eyes, and the comparatively puny size of the bones of the face, which remain unchanged, combine to produce the effect of the head of an adult with the

FIG. 1547.



Separation of cranial bones in hydrocephalus.

FIG. 1548.



Hydrocephalic head.

face of a child, but with a singular expression of premature maturity. (Fig. 1548.) The fluid may amount to three or more quarts. The enlargement of the ventricles takes place at the expense of the brain, so that in extreme cases the neurine almost entirely disappears, or constitutes only a thin peripheral stratum, the substance of which is so altered as to bear but little

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resemblance to brain-matter. As a consequence of this, the nutrition of the child suffers, the flesh slowly disappearing. There is sometimes loss of voluntary control over the muscles of the body, extending frequently to the sphincters of the bladder and the rectum, together with almost utter abolition of the mental faculties. Though in most instances the disease proves fatal in a year or two, cases are on record where the patient has lived to reach adult life. Professor John Neill, of this city, had in his possession the skull of a hydrocephalic subject who had lived to the age of forty, and in whom the sutures had all ossified.

Hydrocephalus Externus is not a ventricular disease, but may be associated with the latter. It is a collection of fluid in the cavity of the arachnoid membrane. It is followed by enlargement of the head, but does not, so long as the sutures are not ossified, exercise so destructive an influence upon the brain as the ventricular form of the disease. When hydrocephalus begins after birth, it is probably of this external variety. Dean Swift is said to have labored under this disease; and it is possible that his violent outbursts of temper, as well as the eccentricities of his character, and the biting sarcasm he so often displayed, were due to cerebral irritation.

TREATMENT.—Congenital hydrocephalus rarely, if ever, yields to medical or surgical treatment. It is stated by Professor Göltz, of Vienna, that of those cases which begin after birth, a majority will recover under proper treatment. Those which yield to remedial measures are probably cases of external hydrocephalus and have an acute origin. The only case of the disease which I have ever seen recover was one of this last kind. The remedies which are employed with the greatest advantage, and which, no doubt, retard in some degree the progress of the affection, are mercurial alteratives, such as small doses of calomel, administered by the mouth, and the unguentum hydrargyri rubbed into the groins and over the inside of the thighs. The action of the kidneys should be stimulated by diuretics, and occasionally a hydragogue cathartic given. When there is much cerebral irritation, indicated by involuntary action of the muscles or by epileptic convulsions, the use of bromide of potassium will serve to diminish in some measure the excitement.

TAPPING.—This operation is quite old, having been, it is believed, first practiced by Le Cat, in 1774. It has been so uniformly unsuccessful that few surgeons recommend the operation at present. Results such as those given by Conquest and West have never been obtained in this country. The former writer declares that he saved 10 out of 19 cases by tapping; and the latter has collected 63 cases of paracentesis for hydrocephalus, 18 of which are represented as having been cured. The operation, if undertaken, should be performed by a very delicate trocar, which should be introduced through the sagittal suture, about one inch behind the anterior fontanel, and to one side of the median line, in order to escape the longitudinal sinus; or it may be done through the lateral ventricle, as practiced by Keen, or by the route indicated on Fig. 342, vol. i. The fluid should be drawn by installments, and taken at intervals of every ten days or two weeks, in order that fatal syncope may not follow the too sudden removal of the pressure. As the liquid is withdrawn and the head becomes reduced in size, it is advised to maintain the reduction by applying adhesive strips about the scalp so as to give support to the diminished walls of the cranium. These should be employed with or without the operation.

Meningocele and Encephalocele.—The initial condition, as has been already stated, in the formation of meningocele or encephalocele, is that of ventricular dropsy. These protrusions may occur at different localities, but generally are found in the occipital region. (Fig. 1549.) I have seen these growths in the parietal and frontal regions, and a number of examples are recorded where the disease has made its appearance at the root of the nose, at the inner angle

of the orbit, and at the anterior fontanel. A curious case of protrusion at the base of the skull was presented to the London Pathological Society, in which the tumor passed into the pharynx by the side of the sphenoid bone and extended into the mouth. Its removal was followed by death.

When the tumor appears in the occipital region, it may pass between portions of the occipital bone, or through the foramen magnum, between its posterior boundary and the arch of the atlas. Meningocele may be associated with a congenital deficiency of some piece of the cranium. In one instance of this kind which I saw, the parietal bone was absent, and the protrusion occupying its position formed a tumor on the side of the head half the size of the cranium. This child lived to the age of ten years, was a pretty, bright, intelligent girl, and was in no respect deficient in intellect. The head was covered with a dense mass of hair, so that the deformity was not very marked. (Fig. 1550.) At the age above mentioned, she fell down a flight of stairs, struck upon the tumor, and died in a few hours with marked symp-

FIG. 1549.



Meningocele.—From a patient brought to the University clinic.

FIG. 1550.



Absence of parietal bone in meningocele.

toms of compression. At the autopsy it was discovered that there was an absence of almost the entire hemisphere on the side of the meningocele, and also that the cavity of the protruding membrane was filled with coagulated blood, death having been caused by a rupture of blood-vessels in consequence of the fall.

DIAGNOSIS.—In typical cases of meningocele and encephalocele there will be little difficulty in recognizing the true character of the disease. The tumor will have a congenital origin, will probably be located in the occipital region, and will have a pedunculated connection with the head. Should the contents of the swelling be fluid, the test by transmitted light will frequently prove as decisive as when applied to a hydrocele. Should the contents be more solid, there will be reason for believing the protrusion to be one of encephalocele; and if pulsation is present, and on pressure a state of torpor or stupor is induced, its central nature is established beyond doubt. There are cases, however, in which the diagnosis is not so readily determined, as where the tumor appears at unusual localities, is small in size, and where there is some uncertainty as to the time of its first appearance. Errors upon this point have been committed, and swellings cut into under the supposition of their being cysts, which proved to be encephalocele. When, therefore, a tumor is observed at the inner angle of the orbit, at the fronto-nasal suture, or in the course of other sutures of the head; when it is found to be reducible by pressure, disappearing from the surface of the head; and when, in addition, there is a history of its being congenital, the intracranial origin of the growth may be inferred with certainty.

TREATMENT.—In most cases little more can be done than to apply pressure to the enlargement by a cup-shaped shield made of rubber or leather and moulded neatly to the parts. To defend the skin of the scalp against excoriation, a thin stratum of cotton can be interposed between the parts and the cup, and the whole kept in place by a night-cap. If successful in effecting some reduction in the size of the protrusion, the cup should be diminished so as to conform to the lessened surface. Cases occasionally occur in which the meningocele undergoes a spontaneous cure. A man consulted me in reference to a tumor over the frontal suture, which had been slowly but steadily decreasing in size for a period as long as he could remember, and which was doubtless congenital. It had become so small when I saw him that it was only when he stooped, or when the head was allowed to hang down for a short time, that it would become visible on the surface. The gradual ossification of the frontal suture was lessening the space communicating with the inside of the cranium, and I thought would in time completely close it up and cure the meningocele. The cases of meningocele which justify a resort to operation are very few indeed. When the protrusion grows rapidly, without any general enlargement of the head indicating the presence of internal hydrocephalus, the tumor may be tapped with a delicate trocar and canula, and afterwards treated by compression. In a case of rapidly

FIG. 1551.



Appearances of meningocele after removal by elastic cord; showing line of separation and section of pedicle.

increasing pedunculated meningocele, hanging from the occipital region, which was brought to the University clinic in 1870, the thought occurred to me of gradually dividing the pedicle by means of an elastic ring. It was accordingly applied, and by a slow process of ulceration the mass was, after ten or twelve weeks, separated from the head. (Fig. 1551.) Shortly afterwards the child died from what appeared to be intracranial inflammation. This was, so far as I know, the first application of the elastic ligature for such an object. Iodine has been occasionally injected with a view to insure a closure of the sac. In all cases of meningocele where the pedicle is diminishing in size and the growth is not increasing, no operation should be attempted. Holmes has suggested a plan of operation for meningocele, as follows: the pedicle is first to be compressed by a clamp, then the tumor tapped and the fluid drawn off, after which the growth should be cut off, preserving two flaps of the integument with which to close the wound, and after twenty-four hours removing the clamp. A novel case of meningocele has been reported by Dr. Leisure, of Alleghany City, in which a cure was effected by tapping, and afterwards invaginating the walls of the tumors, or turning them back upon themselves, so as to occlude the opening in the skull.

In cases of encephalocele no operation will be proper. Our remedial efforts should be confined to giving such support, by means of properly formed shields of tin or rubber, as will tend to restrain the outgrowth of the mass.

CHAPTER XXVI.

SURGICAL DISEASES OF THE MOUTH.

IN this chapter I shall treat of the surgical diseases of the lips, tongue, jaws, gums, teeth, and salivary apparatus.

LIPS.

Deformities.

Contraction of the oral orifice is occasionally met with as a congenital condition. More generally it is the result of burns, profuse mercurialization, or cancerum oris; and in one case, in a child which came under my observation, I believe the contraction was referable to transmitted syphilis. The contraction may be so small as to prevent the introduction of food. Even complete closure has been noticed.

TREATMENT.—When the narrowing is of a character to require surgical interference, the principal point to be kept in view in enlarging the opening is to preserve a sufficient amount of mucous membrane to cover the raw surfaces of the wound, to the cutaneous margins of which it must be stitched by delicate carbolized silk sutures. Silver wire, unless very fine, is too rigid for use in such cases. The mucous flaps are preserved by splitting the tissues at the sides of the contraction, horizontally, introducing a sharp-pointed bistoury flatwise midway between the cutaneous and mucous surfaces of the lips, and dividing them upward and downward for a short distance, after which the inner flap is to be divided in two, longitudinally, and a V-shaped portion cut out of the cutaneous half. The flaps will present the appearance represented in Fig. 1553.

FIG. 1552.



Contracted mouth.

FIG. 1553.



Cutaneous and mucous flaps joined after removing a V-shaped piece from one side.

Mr. Mason, before enlarging the opening at the commissures of the lips, introduces a wire thread at a proper distance from each angle, and, after the openings have healed to the condition of a fistula, the parts are divided from the openings into the mouth.

Eversion and Depression.—The cicatrices resulting from burns about the neck and face often produce unsightly deformities, drawing down the corners of the mouth or causing eversion of the lips. A preternatural length of the frænum labii will also give rise to eversion.

Cases of this kind require for their correction the removal of the cicatrix, and the substitution of healthy integument taken from an adjacent part. In other cases, where the nodular tissue is limited to a portion of the lip, causing eversion, the deformity can be corrected by excising a V-shaped piece from the entire thickness of the lip, leaving the apex of the V (which must correspond with the red border) undivided, and afterwards closing the wound with hare-lip sutures. If the defect is referable to a long frænum, the remedy consists in excising a V-shaped piece from this fold, and permitting it to heal by open granulation, in order to obtain the benefit of some cicatricial shortening.

Chaps and Cracks are frequently observed on the free borders of the lips of persons who are much exposed to extremes of temperature, or who labor under certain disturbances of the digestive organs. These lesions rarely extend deeper than the mucous membrane. They are often very tardy in healing, and occasion considerable anxiety by exciting the apprehension that the lesion may degenerate into cancer. The lower lip is the one generally affected.

TREATMENT.—A little cold cream, camphor cerate, or mutton suet applied to the affected surface will, in simple cases, be all that is necessary to effect a cure. In cases which are more obstinate, an ointment of roses containing a little gallic acid will be found useful; or a powder consisting of equal parts of calomel and subnitrate of bismuth; or, finally, if these remedies fail, a little iodoform may be applied lightly with a camel's-hair brush, and the parts afterwards covered with a piece of gold-beater's skin. In habitually recurring cases of chaps, the greatest circumspection should be observed with regard to the diet, avoiding every article of food which is likely to disorder the digestion, eschewing at the same time all manner of stimulants.

Fissures often appear on the upper lip of children. They are frequently attended with an unhealthy discharge from the nose, which excoriates the skin below, with tarsal ophthalmia, enlarged glands in the neck, and other signs of struma. Cod-liver oil and the syrup of the iodide of iron are the remedies for such a condition, the local lesions being only symptomatic of the constitutional vice.

When cracks are observed about the corners of the mouth, a careful inquiry should be made into the case, as it is not uncommon to find such lesions in persons suffering from constitutional syphilis. When this is the case, the treatment must be antisyphilitic.

Ulcer.—A neglected chap or crack, or one which has been irritated by smoking, is liable to degenerate into a sore or ulcer of considerable depth, with irregular edges, and with unhealthy granulations, which bleed on receiving any slight injury, as in wiping the mouth, or in chewing the food. Using liquid food alone, touching the sore with a crayon of nitrate of silver, or stimulating its surface with iodoform and protecting it with gold-beater's skin, may serve to insure its repair. But if not, it should be excised and the edges closed by the twisted suture. Destructive caustics will also cure an unhealthy ulcer of this kind, but they have the disadvantage of leaving a depression in the lip, which detracts from its appearance.

Hypertrophy.—Two forms of hypertrophy of the lip are met with,—one involving only the mucous and submucous tissue, and the other all the components of the lip. The upper lip is almost always the one affected.

Mucous hypertrophy, often called double lip, consists in the formation of two semilunar duplications or folds of the mucous membrane of the superior lip, one on each side of the median line, which project below, especially when the person smiles or laughs. It might be described as a chemosis of the lip. (Fig. 1554.)

The disease begins in a slight transudation from the vessels of the submucous tissue, gradually pressing the mucous membrane from the under-

lying muscular layer, and accompanied by a new formation of intermediate connective tissue.

The subjects of this affection are usually found among those who possess a scrofulous organization.

TREATMENT.—The treatment consists in including the mucous folds between two elliptical incisions, and, after their removal, uniting the parts with interrupted sutures made with fine silk thread, afterwards keeping the lip covered with a pledget wet in cold water. In four days the stitches can be removed, by which time the union will be found reasonably firm.

General hypertrophy.—There is a general enlargement of the lip noticed in young subjects, which is generally associated with a strumous organization. There is also a tumid lip, produced by causes which interfere with the venous circulation of the head and neck; but it is usually associated with a puffy state of the face.

As the disease does not materially increase with age, it is not desirable to make any attempt to retrench the hypertrophied tissues with the knife. Alterative remedies, as iodine, iodide of iron, and cod-liver oil, while they will prove of benefit to the general health, exert little influence in reducing the local hypertrophy. There is a progressive labial hypertrophy, which consists in a large increase of the connective tissue of the part, with marked enlargement of the lymph-spaces. I saw a young man, about twenty-four years of age, who had this deformity in a very marked degree. The lip was dense, leathery, and very prominent. The hypertrophy was removed by excising a wedge-shaped piece from the projecting portion and uniting the edges of the resulting gap by sutures.

Hair.—Females are often greatly distressed and mortified by the growth of an unusual amount of hair on the upper lip. This may take place early in life, or it may not be sufficient to attract notice until after forty or fifty.

There are certain remedies belonging to the class of depilatories which will temporarily remove this hair, but it soon grows again, as the piliferous follicle is not destroyed. One of the best of the kind, and one which I frequently employ, consists of one part of sulphide of sodium with three parts of prepared chalk, mixed with a little water into a paste and applied to the surface covered by the hair. In a few minutes it can be brushed off, carrying the hair with it.

The radical removal of the hair is most satisfactorily accomplished by introducing a very fine platinum needle into the follicle and connecting it with the poles of an electro-galvanic battery. A few can in this way be destroyed at each sitting, and, though the process is slow, it has the advantage of being sure.

Moles, with or without hair, occupying the lip, when causing annoyance, can be destroyed by applying over their surface a little chloride of zinc paste, or, what is still better, if the patient will consent, by excising them and closing the wound with a silk suture.

Wounds of the Lips.—These are incised, lacerated, gunshot, and poisoned. Lacerated wounds are the most common, and are produced by hooks, by dog-bites, and not uncommonly by the teeth, against which the lips may have been driven by a blow. In the latter case it is quite possible to have an extensive cut on the inside of the lip, without any lesion on the outside. The nearer the wound is to the mucous surface, the more profuse will be the bleeding, as the coronary vessels lie immediately beneath the mucous membrane.

FIG. 1554.



Double lip.

TREATMENT.—All wounds which extend through the entire thickness of the lips require for their proper adjustment the twisted suture, in forming which the pin must be carried to the depth of the mucous membrane, as only in this way can the mouths of the vessels be closed. Ligatures, which interfere with the quick union of the parts, ought not to be used.

The scars which attend lacerated wounds of the lips are, from their conspicuousness, to be greatly deprecated, especially as they do not become less with advancing years, but, on the contrary, grow with the general growth. As an incised wound leaves a much smaller cicatrix than one which is lacerated, I deem it best to convert a lip-wound of the latter variety into one of the former kind by paring away the ragged edges and bringing the sides together after the usual manner.

A lacerated wound which fails to unite from being imperfectly stitched, or from the sutures cutting out too early, should be left until all inflammation, undue redness, and swelling disappear, when its edges can be freshened and brought into contact by means of the twisted suture.

Gunshot wounds of the lips, like the same class of injuries in other parts of the body, will not unite by quick union. They must, therefore, be treated like shot wounds elsewhere,—by water-dressings,—and when the sloughs have been detached and the granulations have become healthy they may be freshened and united. There is often, in these cases of gunshot wounds, extensive destruction of the lips, which can be restored only by cheiloplastic operations.

Poisoned wounds of the lips are generally caused by the sting of a bee or of some other insect. They are followed by rapid swelling and a burning, itching, or pungent pain, which lasts for some hours.

The repeated application of wet clay, or of a strong solution of bicarbonate of soda, will relieve the pain and swelling.

Carbuncle.—A variety of carbuncle in which the swelling is diffused, hard, brawny, and dusky-colored is sometimes seated in the lips. These peculiarities depend in some measure on the anatomical constituents of the part and their arrangement. The disease exhibits a tendency to spread, and is often accompanied with alarming symptoms of blood-poisoning. In one instance I saw a patient die from a carbuncle situated on the upper lip; and Dr. Cockle* has recorded a similar case.

There can be no doubt that in these carbuncular inflammations of the lips, as well as those of other parts of the face, there is a degree of malignancy which does not belong to the disease when seated in other portions of the body.

Mr. Thomas Smith,† of London, in connection with two fatal cases of carbuncle occurring on the face, has thrown out the suggestion that the tendency to constitutional symptoms may be due to the readiness with which the facial veins receive morbid materials.

TREATMENT.—The extension of this form of carbuncle is most surely arrested by free incisions carried down on each side of the diseased tissue, after which the parts should be covered with a warm flaxseed poultice rendered stimulating by being smeared with the compound resin ointment. The subsequent local treatment will not differ from that proper in ordinary carbuncular disease.

The constitutional remedies which will be required are iron and quinine, opium to relieve pain and restlessness, and stimulants, with the best diet.

Tumors of the Lips.

Angeiomatous Nævi.—These vascular formations are frequently situated in the lips, particularly the upper lip.

* Proceedings of the London Medical Society, vol. i. p. 163. Mason.

† British Medical Journal, p. 22, 1870.

When the disease is limited to the cutaneous surface of the lip, appearing as a small red or purple spot, the obliteration of the vessels can often be effected by repeated applications of nitric acid or the acid nitrate of mercury, or the growth can be destroyed either by excision or by passing a pin beneath the spot and surrounding the base with a ligature.

The more troublesome vascular growths of this nature are those which are seated in the mucous surface and those which involve all the tissues of the lips. In some the venous element preponderates, in others the arterial, or the two may exist in nearly equal proportion. The condition is recognized by a soft, spongy, vascular mass appearing on the inner surface of the lip, having a bluish or purple color, which, in cases affecting the whole thickness of the lip, is visible through its cutaneous surface. The tumor enlarges during excitement, as in crying or laughing, and can be deprived of most of its blood by compression, leaving an apparently empty sac, which, however, soon refills on the removal of pressure. These *nævi* may extend to the cheeks.

As these vascular tumors increase with the growth of the child, the earlier they become the subjects of surgical attention the better. There are many ways of dealing with these growths, which have already been discussed at length. (Vol. i. page 511.) There are three modes particularly applicable to *angiomas* of the lip or any part of the face,—ligature, excision, and electrolysis.

The first two are to be used in some of the modes described under the head of *angiomas*.

Electrolysis.—In employing the electrolytic method, if the *nævus* is large, two or three needles are passed into its interior and connected with the negative pole of a battery consisting of seven or eight cells. Another needle is then introduced into the growth, and attached to the positive pole. In a short time the tissue-destruction which is in progress within the tumor will be indicated by little bubbles of gas which make their way by the side of the needles. Coincident with this the blood in the growth becomes coagulated, after which the mass should undergo degeneration and gradually disappear.

Cysts of the lips are caused by the distention of the labial follicles in consequence of obstruction of the excretory ducts. Very small retention cysts may be successfully treated by laying open the sac and turning out the transparentropy contents, and cauterizing the cavity with nitrate of silver; but when the tumor exceeds the size of a pea, nothing short of excision will effect a cure.

Adenomata.—A new formation of the glandular constituent of the lip forming a tumor has been observed in very rare instances by Sir William Lawrence, Sir James Paget, Mr. Goodhart, and Mr. Mason. In the case mentioned by the last-named gentleman, the growth was said to have been caused by a blow received on the lip. The remedy is excision.

Papillomata, both mucous and corneous, may appear on the lip.

Mr. Cock,* of Guy's Hospital, London, records a case of a horny growth attached to the lower lip; a second is noticed by Dr. A. L. Sawyer;† and Professor Gross‡ mentions a third, similarly located, and which was five-eighths of an inch in length.

When horny in their consistence, they should be extirpated with the knife; when soft, or of the mucous kind, they can be destroyed by either mineral or alkaline caustics.

Myxomata.—Tumors of this class are quite uncommon. Only once have

* Medical Times, November 8, 1855.

† New York Medical Times, 1851.

‡ Principles and Practice of Surgery, vol. ii. p. 508.

I seen an example of the disease on the lip. This was on the mucous surface of the lower lip, near the right commissure, in a young lady. It commenced in the submucous connective tissue of the part, forming an oblong swelling which extended forward to the junction of the new border with the skin of the lip, and was filled with a yellow, gelatinous fluid. The disease was cured by excision.

Fibromata.—Only three or four instances of fibrous tumors of the lips have been observed. These have been described as hard, florid, pedunculated enlargements, slow of growth, and insensible to pressure. They are to be treated by excision.

Lipomata.—Fatty tumors of the lip are exceptionally rare. I have never seen an example of the kind. The lobulated form, doughy feel, and dimpled or fissured surface on pressure would establish the diagnosis.

Foreign Bodies sometimes enter the lip in a singular manner, and remain unsuspected for some time, giving rise to indurated tumefactions which have been mistaken for carcinoma. Mason has collected three cases in which the supposed tumor in each was due to portions of a carious tooth which had found their way into the lip, and were discovered only by laying it open.

Epitheliomata are exceedingly common affections of the lip, and almost invariably occupy the lower lip. They are more common in males than in females, in the proportion of twenty of the former to one of the latter. The disease is most common in middle and advanced life, being rarely seen earlier than thirty years.

SYMPTOMS.—Epithelioma commences generally near the vermilion border of the lip, close to the cutaneo-mucous junction, and in one of four ways: 1st, by a localized desquamation; 2d, in a crack or fissure; 3d, in a papillary or wart-like excrescence; 4th, as a minute, shot-like tubercle. Whatever may be the initial appearance, there is always some degree of submucous induration discoverable. A scab at length forms, consisting of epithelial scales mingled with blood, which adheres for a time, and then either drops spontaneously or is detached by the finger of the patient, revealing a raw, ulcerated surface beneath, which after a time becomes again covered by the epithelial debris and unhealthy secretions of the ulcer. This process may be repeated for many months, during which, perhaps, there may be little uneasiness or pain experienced by the patient, though the area of infiltration continues slowly to enlarge. As the disease progresses, the ulcer enlarges; its edges become hard, irregular, and ragged; fungous granulations, which bleed on being handled, and pour out an offensive discharge, overtop the lip, and the patient is harassed with sharp, burning, and lancinating pains.

FIG. 1555.



Epithelioma of the lip.

As the work of devastation advances and the lip is destroyed, the saliva dribbles constantly over the chin and the breast; the disease extends to the gums, jaws, and adjacent portions of the cheeks; the glands in the submaxillary and sublingual regions become affected; the nutrition fails; the sufferer is unable to rest except when under the influence of large doses of opiates; his flesh and strength fail, until at length, after a year or two, worn out by pain and general irritation, death comes mercifully to his release. (Fig. 1555.)

CAUSES.—Nothing definite is known as to the cause of the disease. Little importance is to be attached to the alleged influence of the clay pipe used in smoking as a cause of this affection, since the number of cases as compared with the number of

smokers is too insignificant to give the least credibility to this view. It must not be overlooked, however, that the lower lip is much more exposed to irritation from a variety of causes than the upper lip, and this fact may play no inconsiderable part in the causation of the disease.

DIAGNOSIS.—Epithelioma may be confounded with a benign ulcer, and also with syphilitic ulceration of the lip. From the first it can be distinguished by the absence of induration, and by the tendency in a simple ulcer to heal under appropriate local applications.

More difficulty will be experienced in at once reaching a satisfactory differential diagnosis in cases of ulceration due to a syphilitic origin, as the latter, in general appearance, often makes a very plausible counterfeit of epithelioma. In both there may be a ragged, destructive ulcer; in both the granulations bleed freely; both discharge freely; and in both the glands in the submaxillary region become enlarged. And yet there are very important differences between the two affections: 1st, in the syphilitic disease the ulcer is not necessarily confined to the lower lip: it may be on either; 2d, the pain is never acute and lancinating; 3d, females suffer as often as males, and the young rather than the old; 4th, the patient, notwithstanding the extensive character of the ulceration, will probably be strong and robust, and will present no evidence of general suffering; 5th, the period between the ulcer and the glandular enlargement is rarely more than a few weeks at most; 6th, the progress of the ulceration is a great deal more rapid than that of epithelioma; 7th, in syphilitic ulceration the odor is far less offensive than that of epithelial cancer; 8th, there are present, or have been, other evidences of syphilis, which may be ascertained on inquiry.

TREATMENT.—The only treatment which promises any safety to a patient in a case of epithelial cancer of the lip is an early *excision*. This can be most conveniently and expeditiously effected by cutting out, with a sharp-pointed bistoury, a V-shaped piece of the lip, including a considerable amount of sound tissue along with that which is diseased, and afterwards bringing together the sides of the wound with twisted sutures, introducing the first pin close to the red border of the lip, and carrying it down to the mucous membrane, in order to control the bleeding. (Fig. 1556.) The extensibility of the lips admits of a large amount of tissue being sacrificed without materially interfering with the apposition.

The pins can be removed in twenty-four hours, but the union should be supported by adhesive strips for a few days following. In many cases the disease, when early and properly removed, never returns.

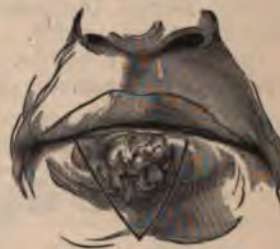
The treatment by caustics has been much abused by ignorant and unprincipled pretenders; it is altogether more painful and less satisfactory than the knife, even when applied by the best professional skill, and should be discarded from use in this disease.

After the lymphatic glands in relation with the lip have become enlarged, operative interference can promise no good result, and is proper only when the object is a short respite from pain, and temporary relief from an offensive sore.

Restoration of the Lips.—In cases of disease or deformity requiring the removal of the entire lip, or of so large a portion that approximation after the usual manner is impossible, the lost part must be replaced by flaps taken from contiguous portions of the face, chin, or neck. These cheiloplastic processes, with a little mechanical skill, will remedy the loss of tissue in a very satisfactory manner.

Restoration of the lower lip.—When the lower lip has been cut away from

FIG. 1556



Operation for epithelial cancer.

the commissures to the chin, as will frequently be necessary in cases of epithelioma, the chasm can be filled by resorting to either the Buchanan or the Sims operation, the details of the two being very much alike, the only difference being that in the former the vertical arm of the incision is curvilinear and the horizontal incisions are nearly straight, while in the latter both are rounded or curvilinear. I have found it necessary, in my own experience, to use sometimes one and at other times the other method, depending altogether on the extent to which the structures of the chin are involved.

The plan of Buchanan consists in taking two flaps from the sides of the chin, formed by making two incisions, the vertical portion of each being slightly oblique, and the horizontal portion straight. (Fig. 1557 will illustrate the direction of the incision.) The flaps, being detached, are next raised into the site of the original lip, and secured by the twisted suture. (Fig. 1558.)

FIG. 1557.



Portion of lip removed, and lines of incision for the formation of a new one.

FIG. 1558.



Flaps raised into place and retained by pins ready for the twisted suture.

The raw surface from which the flaps are taken is next to be closed by sutures.

Restoration of the upper lip.—In restoring the upper lip the material for the raw one must be taken from the face external to the alæ of the nose. Several very ingenious operations have been devised for the purpose by Morgan, Sédillot, Bérard, Dieffenbach, and others. That of Dieffenbach gives, perhaps, the neatest appearance.

Dieffenbach's operation.—The operation of this surgeon is done by first freshening the remains of the original lip, then raising two S-shaped flaps,

FIG. 1559.



a, lost part of upper lip; b b, flaps on each side of nose.

FIG. 1560.



Flaps in position and wounds on each side of the alæ of nose closed by interrupted sutures.

one from each side of the alæ of the nose (Fig. 1559), and turning them across the chasm in front of the alveolus and uniting them together in the

median line, as also to the vivified surface of tissue beneath the nose. (Fig. 1560.) In cases where the upper lip has been destroyed, a new one may be formed by flaps raised from each side of the lower lip, turned across the chasm, and united by the interrupted sutures. (Fig. 1561.)

FIG. 1561.



Sédillot's method of forming upper lip.

Hare-Lip.—Hare-lip is a congenital deformity in which the two sides of the lip fail to unite. The analogy between this defect in the human lip and the normal conformation of the lip of the hare is not strictly correct, as has been shown by Geoffroy Saint-Hilaire, the cleft in the latter being exactly in the median line, while in the case of the child it is always to one side of the centre. The deformity answers, as the same writer states, to the notched lip of fishes. It is often associated with club-foot and other congenital malformations.

Hare-lip should be studied in connection with fissure of the hard and soft palate, and becomes intelligible only when investigated from the stand-point of embryology. Anterior to the second month of fetal development, the divisions mouth, nose, and pharynx, which we speak of in the child at birth, do not exist, all of these compartments forming a common cavity. These cavities are all differentiated—provided no arrest in the process of development occurs to prevent—by the completion of the sixth month of intra-uterine life. The palatine plate of the superior maxillary at this time consists of three parts, separated posteriorly by a median line and anteriorly by two diverging lines of sutures. The piece embraced between the anterior sutural depressions or fissures is the intermaxillary bone, and bears the incisor teeth, while in the alveoli of the other two halves are lodged the germs of the canine, bicuspid, and molar teeth. The uvula belongs to the palate plates of the palate bones, and the upper lip to the alveolar processes of the intermaxillary and maxillary bones. When nothing intervenes to disturb the orderly development of the parts, the horizontal plates of the superior maxillary, the intermaxillary, and the palate bones approach one another and unite, thus establishing a partition between the nasal cavities and the mouth, the arches of the soft palate and halves of the uvula coalesce, forming a curtain between the mouth and the pharynx, and the upper alveolus is completed in front, forming the anterior boundary of the oral vestibule. Should, however, some subtle influence prevent the complete closure of the posterior extremity of the palatine suture, a cleft would follow. If the anterior portion of the same suture fails to close, there remains a more extensive cleft, which may also be complicated with non-union of the sutures which unite the intermaxillary with the two halves of the upper maxillary bone, and, if there is the further deformity of hare-lip, the cleft is complete from the outside of the face to the pharynx.

Hare-lip may be single or double, the defect or fissure being always oppo-

site to the location of the intermaxillary sutures, and, when unilateral or single, generally on the left side.

Single Hare-Lip.—In single or simple hare-lip the cleft generally extends upward into the corresponding naris, one side—the inner—of the chasm being continuous with the septum narium, and the other, or outer, with the alæ nasi, making an uninterrupted communication between the oral fissure and the cavity of the nose. The lower margins of the two halves are rounded, as is also that of the cutaneous surface of the cleft, but the junction of the inner and posterior surfaces is almost rectangular. The mucous membrane of the jaw covers both sides of the gap, and the outer half of the lip is usually on a plane anterior to the other, and, being the shorter half of the two, is much more under the influence of the muscles on that side of the face, as are also the alæ of the nose, which, by their contractions, serve to change the form of the naris and to increase the gap, and in the case of adults to cause an unpleasant exposure of the teeth.

COMPLICATIONS.—The complications of single hare-lip are those in which the gap is very great, requiring much tension to bring the sides of the lip into contact; great deficiency in the sides of the lip; great prominence of the bone on the intermaxillary side of the cleft, so that when the approximation is made in the operation the corresponding half of the lip is strapped so tightly over the eminence as to interfere with its proper nutrition, causing the sutures to ulcerate through the tissues before union has had time to occur; and, lastly, general malnutrition.

Time to operate.—On this subject there is some difference of opinion among surgeons, some advocating early operations,—and by the term early I mean any time between birth and the third month succeeding,—while others prefer waiting until after the eruption of the first set of teeth. Personally, I attach much more importance to the general health and vigor of the child than to the consideration of age. If the physical condition does not contra-indicate surgical treatment, the operation may be done at any time after the second week. By this time the functions of the organs are well established, and the child has acquired vital capital sufficient to resist the shock incident to the procedure.

The existence of a cleft in the alveolus or hard palate renders an early operation desirable, as the traction which follows the union of the lip tends to diminish that in the bones.

In complicated cases of single cleft it is better to wait for four or five months. Whatever may have been the experience of other surgeons in cases of this nature, my success in early operations has not been encouraging. It is hardly necessary to say that during indispositions from primary dentition, or from any other cause, no operation will be proper.

OPERATION.—The operation embraces the manner of securing the child, of freshening or paring the edges of the cleft, of closing the wound, and the subsequent treatment.

Holding the child.—The child, preparatory to the operation, should have the arms pinioned to the sides by means of a towel wrapped firmly round the body and pinned fast, though not so tight as to interfere with the breathing; the latter caution is important in the event of an anæsthetic being administered, which, unless there is some very cogent contra-indicating reason, should always be done; its influence need not be kept up any longer than during the time occupied in paring the edges of the fissure.

After the child has thus been secured, it may be laid either on a table or across the knees of a nurse, one assistant holding its head steady, while a second keeps the body from wriggling and attends to sponging out the blood which accumulates in the mouth and pharynx during the operation, for which purpose there should be provided small bits of sponge securely fastened to wooden handles or locked within the grasp of forceps.

These preliminaries being arranged, the operator, standing or sitting behind the head of the child, seizes the lip between the thumb and fingers,

and detaches it from the jaws on both sides of the fissure by dividing with a narrow-bladed, sharp-pointed bistoury the labio-maxillary folds of mucous membrane preparatory to paring the edges of the cleft.

There is an invincible tendency in the free borders of vivified tissues to become rounded, for nature abhors rectangular forms. The effect of this tendency is to leave, after union has been secured between the two sides of the hare-lip, a little notch at the bottom or free border, which materially affects the good appearance of the patient. To prevent this the ingenuity of operators has been taxed to the utmost, and with a result which shows that this natural law cannot be satisfactorily contravened. The old form of incision is the V reversed. (Fig. 1562.) To obviate this defect, one surgeon makes his incisions semi-elliptical (Fig. 1563); another, triangular (Fig. 1564); a third, with reversed triangles (Fig. 1565); and a fourth uses the parings in such a manner that they are not severed at the lower borders of the two flaps, but are turned down as two fleshy tongues. (Fig. 1567.)

FIG. 1562.



FIG. 1563.



FIG. 1564.



FIG. 1565.



Different forms of incision in hare-lip.

The design in fashioning the incisions after the different forms described is to make the force applied in approximating the margins of the wounds operate in pushing out or elongating the parts at the free border of the adjustment. I have practiced all these methods, and am disposed to give the preference to two, namely, the double triangle (Fig. 1564) and the one in which the parings are preserved below, commonly known as the method of Mr. Collis, of Dublin. (Fig. 1567.) In making the lower sides of the triangles, the lower lines of the figure should be formed well down towards the lower borders of the lips, wholly at the expense of the red mucous surface, the plan of Clémot and of Malgaigne. (Fig. 1564.)

To return to the operation. After detaching the lip from the jaw the operator pushes the point of the knife through the lip on one side of the cleft, and, with a sawing motion, pares away the margin from above downward in the angular manner described. The opposite side is to be treated in the same manner, and in each instance, before the side of the lip is released from the grasp of the surgeon, an assistant presses the cheek between the thumb and a finger, external to the angle of the mouth, in order to compress the

coronary vessel and prevent bleeding. A clamp may be used for the same purpose.

A third stage consists in the approximation and retention of the sides of the wound. This can be done either by the interrupted silver suture or by pins and threads. The latter are to be preferred. The objection to the pin is the resulting scar; but the pin which I use is very much more delicate and longer than the pins generally employed. It is not much thicker than the silver thread, has a large glass head, and a very keen point, which penetrates the tissues with the least possible force, and is amply sufficient for the purpose of closure. The first pin should be passed across the extremity of the wound, just at the junction of the vermillion border with the skin, and through the whole thickness of the lip down to its inner or mucous surface, in order to command the orifices of the coronary arteries. This point must not be neglected. A second and sometimes a third pin is to be introduced in like manner, higher up, while the mucous border is secured by a single stitch with a few silk threads, after which the parts are to be drawn together by passing figure-of-eight sutures of silk threads. (Fig. 1566.) The

Fig. 1566.



Cleft closed by the twisted suture, and point by the interrupted suture.

points of the pins are now to be clipped off with pliers, and little strips of plaster slid under their extremities to protect the skin from pressure, after which additional support may be given to the wound and the tension on the sutures lessened by a few narrow adhesive strips passed across the lip from one cheek to the other.

Before leaving the child, the inside of the lip should be carefully examined, to see that there is no bleeding. Children bear the loss of blood badly. Should any leakage exist, it at once excites the child to sucking, which favors the hemorrhage, and, as the blood is swallowed, a fatal collapse may follow without a drop appearing externally.

AFTER-TREATMENT.—For seventy-two hours after the operation the child should be fed with the spoon, sucking having a tendency to interfere with the healing. Fretfulness and crying are to be controlled by an occasional dose of paregoric or of laudanum.

Forty-eight hours after the operation the pins may be safely removed, and in doing this considerable care is requisite that the wound shall not be torn open. The child is to be held very much in the same way as during the operation. An assistant presses the cheek together between the thumb and fingers, placed on opposite sides, so as to allow no strain on the wound. The surgeon removes the adhesive strips, and then proceeds to withdraw the uppermost of the sutures. This is done by seizing the head of the pin with one pair of forceps, and rotating it two or three times before using traction, in order to loosen its hold, while at the same time, with a second pair of forceps planted astride of the pin close to where it enters the flesh, counter-pressure is made, so as to prevent any drag on the tender cicatrix. The first suture being removed, a narrow strip of plaster is to be placed across the lip before the second suture is disturbed, after which the other pin or pins can be removed with the same precautions.

The loops which adhere to the surface of the lip, glued to the parts by the secretions from the wound, are sometimes allowed to remain, as they still play the part of sutures. When this course is adopted, the strips of plaster which are drawn over the threads ought to be removed in twenty-four hours, and the loops detached; otherwise they are liable to produce excoriation or even ulceration of the lip.

Operation of Collis.—This plan consists in removing from the sides of the

cleft a strip of tissue as low down as the cutaneo-mucous line at the lower border of the lip, and then turning the flaps down so that their raw surfaces will come together and the two form a teat or protuberance below. (Fig. 1567.) The sides of the cleft and the flaps below are to be united as in the preceding operation, the former by the twisted and the latter by the interrupted suture. In time the fleshy prominence atrophies, and may never require any retrenchment, being simply a little papilla at the bottom of the union.

The *complications* which have been noticed as offering an obstacle to the successful closure of the cleft in single hare-lip practically resolve themselves into a single one, namely, too great a space intervening between the sides of the labial cleft to admit of easy adjustment. This must be overcome by not only freely detaching the sides of the lip from their connection with the alveolus, but possibly by carrying the incision round the alæ of the nose and separating the corresponding portions of the cheek from the bone. As the lateralis nasi artery will be divided in so doing, unusual care must be taken to secure the vessels. Another plan, devised by Giralde's, consists in making the incisions on each side of the fissure, so that by turning the flaps in different directions the gap may be closed without tension. An angular incision is made on one side of the lip, beginning at its lower free border, and stopping short of its nasal surface, the vertex of the angle presenting towards the fissure, and the longest side of the triangle being the lower; a second angular incision is made on the other half of the lip, beginning above the vertex, directed towards the corresponding naris, and leaving the lower border of the lip undivided. The approximation is accomplished by bringing one flap down and the other up, the raw surfaces opposing each other in a manner to give an oblique direction to the wound.

FIG. 1567.



Appearance of the lip after Collie's operation.

Double Hare-Lip occurs under two forms, the *simple* and the *complicated*.

The simplest variety is that in which there exist two clefts, with an ample intermediate piece, without any prominence of the intermaxillary bone, the segments of the lip being on the same plane, and the nasal septum not displaced. There is very little difficulty in managing a case of this kind.

OPERATION.—As the middle piece in double hare-lip seldom has the same length as the sides, it is not possible to make the lower border of the three come into line during the approximation: so that there are two ways of dealing with this intermediate piece.

First. After dividing the labio-maxillary folds of mucous membrane, and paring the four borders of the two clefts, the lateral pieces are brought together below by the twisted suture, the middle piece filling up the space above and between to the greatest extent possible without being stretched. The pins, in passing from side to side, penetrate the entire breadth of this central piece. (Fig. 1568.)

FIG. 1568.



Double hare-lip, with lines for paring the margin.

Second. Should the lateral portions of the lip be ample and the septum of the nose displaced so as to allow its point to sink or become flattened on the

face, it will be best, after dissecting the intermaxillary part of the lip loose from the bone and freshening its lower half, to utilize it as a column on which to raise and support the flattened nose, by pushing it up and securing its tip in the notch between the lateral portions of the lip.

The graver and more complicated forms of double hare-lip are those in which there is a wide gap in the alveolus, or a great prominence or projection of the intermaxillary bone. This piece sometimes stands out almost



Fig. 1569.
Anterior projection of the intermaxillary bone.



Fig. 1570.
Under surface of the intermaxillary bone, showing the gap between the superior maxillae.

horizontally from the face, surmounted by a mere nodule of flesh. (Fig. 1569.) The bone is often connected with the nasal septum by a small pedicle. (Fig. 1570.) How, then, shall this complication be dealt with? The cleft in the alveolus, indeed, that of the whole hard palate, which may complicate either single or double hare-lip, can be markedly diminished if the attempt is made early, while the bones and

the attachments are yet plastic, by lateral pressure applied to the cheeks. There are three ways in which this can be done: 1st, by the nurse several times each day pressing the bones towards the mesial line, by placing the thumb and finger on opposite sides of the face over the upper jaw, and keeping up firm pressure for one or two minutes; 2d, by exerting a similar pressure with a truss, such as is sometimes employed after operations, the pads of which are to substitute the thumb and fingers of the nurse (Fig. 1571); and, 3d, by a plan recommended by Dr. Hüllihen, of Wheeling, West Virginia, which consists in applying to each cheek a few strips of adhesive plaster and uniting their free ends across the defective lip by strong silk ligatures, which are to be tightened from day to day.

If the sides of the chasm are brought together, a permanent union can be effected by paring the edges of the cleft and holding them in apposition by a ligature passed through the bone a short distance from each edge of the fissure and tying the ends together,—an operation first planned by Dr. Fandenberg, of Maryland.

In cases of complication arising from a prominent intermaxillary, it is always desirable to preserve this bone when this can be done without causing the defeat of the lateral union. When this piece is removed, it is necessarily

followed by a very unpleasant recession of the lip after the cleft has been closed.

There are three ways of overcoming the obstacle of an unusual projection of the intermaxillary bone. 1st. It may be cut away from its attachment to the nasal septum. 2d. It may be pressed back into its functional position by breaking its connection with the septum. 3d. In addition to being re-



Fig. 1571.
Hainsby truss for making pressure on upper maxillae.

stored to the intermaxillary chasm, an effort may be made to secure its union to the maxillæ.

In the slighter degree of the deformity, and where the attachment to the septum is comparatively narrow, the first plan will often fulfill every expectation.

The restoration is accomplished after separating from the bone the fragmentary piece of lip, by planting the thumb against the projecting piece, or by seizing it with a pair of forceps, the blades being covered with rubber or leather, and forcing it directly backward until it sinks into the open space behind, after which the different portions of the lip, being pared in the usual manner, are brought together in front. Where the base of the intermaxillary is broad and strong, it may be necessary to weaken it by cutting out a V-shaped piece from its posterior edge before attempting to break it.

When the intermaxillary is very salient, its attachment formed by a slender pedicle, and the cleft posteriorly not very wide, the bone should be cut away with a pair of bone forceps. Free bleeding from the artery of the septum may be expected to follow this procedure, but this can be controlled either by plugging the orifice of the long canal which contains the vessel with a piece of pine wood sharpened to a point, or, what will occupy less time, by touching the mouth of the artery with the fine point of a cautery-iron.

Disposing of the bone by reduction, with a view to secure its union with associate parts, may be undertaken when the child is vigorous and capable of sustaining a prolonged operation and considerable loss of blood. Various methods of effecting this have been practiced at different times. A V- or wedge-shaped piece can be excised from the septum of the nose and the intermaxillary bone forced back into the cavity. (Blandin.) Or a more formal operation may be done by not only removing the wedge-shaped piece from the septum nasi, but, in addition, paring the intermaxillary piece into a shape to fit the cavity and holding the two in contact by a silver suture, either passed through both transversely or through the septum above, and afterwards brought down and twisted below the intermaxillary bone. (Braun, Langenbeck.) The last-named surgeon has attempted to substitute for the silver thread through the bones flaps of mucous membrane raised from the palatine plates of the upper maxillary, and uniting the same across the intermaxillary. It would be well, when an operation of this nature is done, particularly if the child is not vigorous, to divide the procedure into two installments, allowing some time to elapse between, the first being limited to the proper disposition of the intermaxillary bone and the second to closing the cleft in the lip.

In all these operations for displacing the intermaxillary bone, either the teeth which this piece of the maxilla contains will be lost, or they will, after their eruption, have a vicious position and require to be extracted.

In all cases of failure to secure immediate union between the sides of the lip, both in single and in double hare-lip, the parts should be retained in as close apposition as possible by adhesive strips, as the cleft may be considerably diminished by the union of the granulations in the process healing.

Fissures of the Lower Lip have rarely been observed. Not more than three or four instances of the deformity are recorded. The location of those which have been noticed was in the mesial line. Should a case of this nature be encountered, the treatment would be the same as that required for a cleft in the upper lip.

Commissural Fissures, or Macrostoma.—Several instances of congenital fissures of the cheek, commencing at the angle of the mouth and running directly back towards the ear, or upward in the direction of the malar bone, or downward in the direction of the lower jaw, have been recorded by Klein,

Lacoeche, Nicate, Langenbeck, Fergusson, Gross, and Ashhurst. These defects are often associated with other deformities, particularly of the ear.

The margins of the fissure are to be freshened with the knife, and brought together with interrupted sutures.

Diseases and Injuries of the Tongue.

Congenital Absence of the Tongue is so rare as to be phenomenal.

An interesting case of the kind is given by M. de Jussieu, of a young girl fifteen years old, whom he saw at Lisbon. She was able to speak with entire distinctness, though her words were enunciated slowly. The sense of taste was not lost, and the only inconvenience she appeared to experience from the defect was some trouble in mastication.

Adhesion of the tongue to the jaw or to the floor of the mouth has sometimes been met with. The same writer who notices the case of the tongueless girl mentions an instance of this kind recorded by M. Sernin, of Narbonne, occurring in an infant, in whom the organ was attached as far forward as the tip of the concave surface of the lower maxillary. The tip and margins were successfully dissected free, and the child permanently relieved. Bands of adhesion sometimes follow the sloughing incident to salivation and cancrum oris, and may require to be divided with the scissors or the bistoury.

Bifid or forked tongues have also been noticed.

Tongue-Tie consists in a preternatural shortening of the *frænum linguae*, the little fold of mucous membrane extending so near to the tip of the tongue as to prevent the protrusion of the latter beyond the teeth.* The physician will often be consulted by anxious mothers with reference to what they believe to be tongue-tie in their infants when nothing of the kind exists. Whenever a child can carry the tongue sufficiently far forward to touch the red border of the lower lip, there is no tongue-tie. The ill effects of a short *frænum* left undisturbed are experienced both in sucking and, later in life, in more or less difficulty in articulating.

TREATMENT.—The defect is readily corrected by dividing the shortened *frænum* and releasing the extremity of the tongue. Simple as the operation is, considerable care will be required in its execution, in order that no injury may be sustained by the ranine arteries. Numerous accidents of this nature have happened, endangering to the last degree the lives of children from hemorrhage. A blunder of this kind is easily avoided by not cutting too close to the tongue, on the under surface of which the arteries run.

The operation can be most conveniently done by raising the tip of the tongue with the index and middle fingers, placed on either side of the *frænum* (Fig. 1572), while with a pair of blunt-pointed scissors the restricting bridle is snipped, a little nearer to the floor of the mouth than to the under surface of the tongue; or the latter can be raised on the handle of a grooved director (Fig. 1573), the *frænum* slipping into the notch of the instrument, when the division can be effected. There is no necessity for making an extensive incision. A nick to the extent of an eighth or at most a quarter of an inch is sufficient.

There is a certain degree of inability sometimes experienced in raising the tongue to the roof of the mouth, to which considerable importance has been attached in cases of stammering, and for which division of the anterior fasciculi of the *genio-hyo-glossi* muscles was at one time practiced by Dieffenbach. I have performed a subcutaneous myotomy of the anterior part of the muscle sufficiently often to satisfy myself that it has nothing whatever to do with the defect. I believe at present that it is to be referred to central causes affecting the co-ordination of the muscles of the tongue and fauces.

Among other congenital peculiarities of the tongue which have been noted

* Clarke on Diseases of the Tongue, p. 39.

by writers, more curious than instructive, is preternatural mobility of the organ. Crosse, of Norwich, mentions the case of a lad who could swallow

FIG. 1572.



Cutting the frænum in tongue-tie.

FIG. 1573.



Division of the frænum while held up by director.

his tongue at pleasure, and instances have been given where children have actually suffocated from a like latitude of movement in the organ.

Hypertrophy of the Tongue, mentioned by Celsus, is well described by Boyer, and also by Percy and Laurent. The writers on the subject in later times have been Lassus, Crosse, Paget, Humphrey, Liston, Fergusson, Hodgson, Teale, Maas, of Breslau, Syme, and others.*

It is generally congenital, occasionally acquired. Females appear to be more subject to the disease than males. Clarke has collected 42 cases of lingual hypertrophy, 21 of which were in females, 17 in males, and in 4 the sex is not given. When acquired, the affection, if not caused by excessive mercurialization, or by some antecedent attack of fever or epilepsy, usually commences in childhood. The tongue, greatly thickened and elongated,

FIG. 1575.

FIG. 1574.



Hypertrophy of the tongue.



Hypertrophied epithelial cells observed in hypertrophy of the tongue.

hangs from the mouth (Figs. 1574 and 1575), there not being room for its accommodation within the cavity. In one case related by Clarke, which

* Transactions of the Provincial Medical and Surgical Association, 1857. Clarke on Diseases of the Tongue, pp. 113-134.

was operated upon by a surgeon of Stockholm, the organ projected from the mouth four inches.

The teeth are turned out of their usual course, and the lower jaw is altered in shape, increasing the space between the incisors and bicusps of the upper and lower maxillæ, for the accommodation of the hypertrophied organ. The exposed portion, being subjected to various irritants and lacking the normal pressure of the jaws, increases much more rapidly than the part within the mouth, the weight continues to drag the organ still farther out, and, with its enlarged papillæ giving a warty appearance to the surface, and the dribbling of the saliva, it forms a disgusting object. The pathology of the affection consists in a new formation of connective tissue, along with an unusual development of lymph-spaces, and degeneration of the intrinsic muscular structure of the organ. The vascularity of the tongue is also greatly increased.

There is a prolapse of the tongue which is sometimes observed in infants and in idiots, which, however, is essentially different from the hypertrophy under consideration, being due merely to muscular relaxation, and not to structural changes.

TREATMENT.—The treatment of hypertrophy of the tongue is by compression, excision, and amputation.

Compression.—In applying compression, which is often a difficult and unsatisfactory operation, the tongue, when not too large, may be pushed back into the mouth and retained by binding the jaws together with a Barton roller. The bandage will require to be removed frequently in order to permit of the administration of nourishment and the cleansing of the mouth with a solution of myrrh.

In children old enough to co-operate with the physician in carrying out compression, it will not be necessary to take off the bandage oftener than once daily, as they will be able to draw a sufficient amount of liquid food between the teeth for their support. Or the tongue may be well dusted with alum or gallic acid, swathed in a piece of old linen, or wrapped firmly with either a piece of tape or a narrow gum-elastic bandage.

Excision.—When pressure fails, it will be proper either to amputate or to retrench the tongue by excising a V-shaped portion sufficiently large to reduce the tongue to the proper size, after which the chasm is to be closed by bringing its sides together with deep sutures used transversely.

Of the 42 cases collected by Clarke, to which allusion has been made, 39 were cured and 3 died. Of the 39 cured, 9 were treated by compression alone or aided by lotions, 18 by amputation, 7 by ligature, and 5 by excision. The 3 fatal cases, one of which died of pyæmia, one of laryngitis, and one of pneumonia, were treated, the first by ligature of the lingual arteries, the second by excision and compression, and the third by amputation with the *écraseur*. This affection is sometimes designated by the terms *macro-glossa*, *prolapsus linguæ*, and *lingua vituli*.

Atrophy of the Tongue is much less common than hypertrophy. It may be bilateral or unilateral, and is generally connected with some pressure or lesion affecting the nerves of the tongue or the centres from which they arise.

This atrophy has been observed as a consequence of lingual paralysis. Hughlings Jackson* has reported a case of bilateral atrophy, the sequence of hemorrhage into the medulla oblongata, which is a good example of atrophy from central lesion. In illustration of atrophy following pressure may be mentioned the case given by Sir James Paget, in which a man suffered from unilateral atrophy of the organ consequent upon a fall on the back of the head. About a year after the accident an abscess formed and a piece of bone was removed from the base of the skull, after which the tongue recovered almost completely its natural size.

* London Lancet, Nov. 30, 1872.

The remarkable case of Dupuytren, in which the atrophy was caused by pressure on the hypoglossal nerve by hydatids in the anterior condyloid foramen, was not explained until after death.

Atrophy of the tongue is not necessarily followed by the loss of taste or even of sensibility, as is shown by a case of Romberg's. Unless the atrophy is the result of pressure from causes which are removable, as in Sir James Paget's case, recovery cannot be looked for.

Glossitis, or inflammation of the substance of the tongue, may arise from lacerated or poisoned wounds of the organ, from the injudicious use of mercury, or from corrosive and other irritating substances taken into the mouth. Occasionally it has been seen to appear during the progress of certain eruptive fevers, particularly in hot climates; and it has also resulted from cold. Twice have I seen a glossitis follow a wound of the tongue, which in one case had been forcibly caught between the teeth, and in the other had been torn with a hook. Aggravated cases of glossitis have rapidly ensued from the sting of a bee which had been taken into the mouth while eating honey. During the reign of mercury, when the drug was used in the most reckless manner, swollen tongues from inflammation were by no means uncommon.

I have seen the organ swell so as rapidly to fill the mouth immediately after an inadvertent drink of strong lye or of liquor ammoniæ.

The inhalation of steam may cause the same inflammatory swelling. De la Malle* gives a singular case of a person who, on a wager, attempted to eat a live toad. Shortly after the disgusting task had been undertaken, his mouth, lips, and tongue became swollen, and the glossitis was relieved only by free incisions being made into the tongue. Sir James Paget has noticed a case of glossitis following an attack of scarlatina, and Graves, of Dublin, another in the person of a medical student who was laboring under a febrile attack.

The rapid swelling which attends glossitis is readily understood when the anatomy of the tongue is recalled; the organ containing very little connective tissue, and consequently offering little resistance to the transudation of serum and leucocytes.

TREATMENT.—The treatment of glossitis must be regulated according to the cause. When idiopathic, or arising from constitutional causes, a purgative, followed by scarification of the organ, or by the application of leeches over the submental and submaxillary regions, will be indicated. The mouth must be rinsed out frequently with a warm decoction of sage containing a little borax or chlorate of potash. The diet should be wholly liquid, as milk and beef-tea, and the patient must avoid speaking or using the tongue in any unnecessary way.

Mercurial glossitis requires the frequent use of mouth-washes, the best being a solution of chlorate of potash, or a decoction of the berries of the *rhus glabrum*, and internally the administration of the iodide of potassium. The gravest cases are those which arise from a poisoned wound, as that inflicted by the bee, or from contact of the organ with corrosive acids; in these the swelling may be so great as to threaten suffocation, the root of the tongue encroaching on the top of the larynx. These require bold and decisive measures.

Two free longitudinal incisions carried into the substance of the organ must be made, and usually have the effect of unloading its tissues of the inflammatory transudation and removing the swelling. Any chronic thickening which may remain after an attack of acute glossitis must be treated by a carefully regulated diet, from which are excluded all hot aromatic substances, also wines and all alcoholic beverages, unless the exhaustion of the patient demands stimulants, when beer, or ale, or claret should be preferred to liquors of heavier body. Tobacco also must be forbidden. The remedies most likely

* Mém. de l'Académie de Chirurgie, vol. v.

to conduce to the removal of the induration are the iodide of potassium and the bichloride of mercury.

In acute cases of glossitis, when life is threatened from suffocation, it may be necessary to open the trachea and introduce a tube, until the urgency of the symptoms has passed away.

Fissured Tongue.—This condition, in which cracks or fissures appear both in the sides and over the dorsum of the organ, generally depends on protracted derangement of the digestive organs, such as is frequently seen in old dyspeptics. It may have a syphilitic origin also. These cracks seldom extend far into the tongue, and in mild cases amount to little more than shallow grooves between the papillæ.

TREATMENT.—Neither internal nor external remedies possess much curative value, unless accompanied by a diet the articles of which are easily digested, and which is rigidly adhered to. The work of digestion will be aided by the use of five grains of pepsin at each meal, and by securing daily alvine evacuations. The repair of the fissures may be promoted by the use of a wash of chlorate of potash, of tannin, or of tar-water, and particularly by filling up the cracks with subnitrate of bismuth mixed with glycerin and rose-water to the consistence of a thick cream.

Syphilitic fissures must be treated by the iodide of potassium and the bichloride of mercury.

Papillary Disease.—Two morbid affections of the papillæ of the tongue occasionally come under the observation of the surgeon, which are sometimes found to be associated with certain squamous diseases of the skin, both syphilitic and non-syphilitic, and also with disturbances of the digestive organs.

The milder of the two affections, the *psoriasis linguæ* of writers, appears as a white and gray patch of closely aggregated epithelium, traversed by fine branching grooves. After a time the patch becomes detached, and there remains a raw surface having an intensely red color. This process undergoes repetition, lasting for years, or the patch may, under some simple application, heal up, and be followed by others over different portions of the dorsal surface of the tongue. When the disease continues for some time, a disorderly development of the epithelium and its papillæ occurs, which, as the irregular patches are thrown off, leaves an ulcerated surface. This more aggravated form of the affection is designated *ichthyosis linguæ*; the tongue is subject to great variation in appearance, sometimes being coated with a dense fur, at other times being almost entirely clean. When the epithelial cells, instead of preserving their superficial position, obedient to the laws of desquamation, begin to infiltrate or penetrate the lingual papillæ, the disease assumes a very threatening aspect, and will probably degenerate into epithelial cancer.

Ichthyosis of the tongue may arise from both local and constitutional causes. Glass-blowers are thought by Dr. Andrew Clarke to be especially liable to the disease. Others attach much importance to syphilis as a constitutional cause.

In the treatment of the disease the influence which the digestive organs exert over disorders of the tongue must not be overlooked, and every attention must be given to correct any defect which can be traced to this source.

Arsenic administered internally has been extolled, and if any syphilitic infection is suspected it will be proper to resort to remedies suited to combat this poison. Should the disease assume a malignant form, amputation alone offers any hope of cure.

Wounds of the Tongue.—The tongue is exposed to the same variety of wounds as other parts of the body,—contused, incised, lacerated, punctured, poisoned, and gunshot.

Contusions and slight abrasions, or surface wounds, of the tongue are fre-

quently produced by the organ being caught between the teeth in falls or during an epileptic convulsion, and demand no other attention than the frequent employment of warm chamomile tea or of warm water containing a little borax as a mouth-wash, at the same time using liquid nourishment until the parts have recovered.

Incised wounds are commonly produced by the teeth; sometimes by a person falling with a knife placed across the teeth. I have in a number of instances seen the tongue almost entirely severed by these means, the two parts retaining their connection by a very narrow strip of tissue.

In both incised and lacerated wounds the parts require to be brought together by the interrupted suture. In doing this the patient should be etherized, in order that the surgeon may have complete control of the organ. Silk sutures are to be preferred, and can be passed most satisfactorily by a curved needle supported on a holder.

The stitches should extend either the entire depth of the wound, or, when the latter involves the whole thickness of the tongue, they may be applied on both aspects of its surface. They should remain five or six days before being removed. When a wound of the tongue has been neglected until its surfaces are no longer raw, it will require to be refreshed before the sutures are inserted.

Gunshot wounds of the tongue cannot be united by suture, but must be allowed to granulate and heal, after which, if the parts admit, they are to be pared and brought together like an ordinary wound.

Punctured and poisoned wounds are dangerous on account of the tendency to inflammatory infiltration: when this becomes threatening, one or two free longitudinal incisions will be required.

Abscess of the Tongue is one of the sequences of a localized glossitis, and may be caused by contusions, irritants, and cold. It is preceded by soreness and swelling in a portion of the organ, followed by shiverings and fever. The comparative absence of connective tissue in the tongue favors the diffusion of the suppuration, which may accumulate, particularly when the abscess is near the root of the tongue, so that, together with other products of inflammation, it occasions such pressure at the top of the larynx as to threaten suffocation. The disease is liable to be mistaken for simple glossitis, but may be distinguished by the tendency in the swelling to point, by a feeling of fluctuation, and by the history of chills. When the surgeon is not clear in his diagnosis, the introduction of the exploring needle will remove the obscurity.

The remedy consists in making an opening into the abscess and evacuating the contents.

Sublingual abscess.—There is an inflammation occasionally seen which commences in the cellular tissue under the tongue, and which tends to displace the organ, and when the pus works its way backward it is apt to make alarming pressure in front of the epiglottis, occasioning great embarrassment to the respiration. These abscesses can be opened either on the side of the tongue or in front of the neck beneath the chin.

Ulcers.—Ulcers of the tongue arise from dyspeptic, syphilitic, parasitic, and strumous causes, and from gastric and intestinal disturbances.

The sore, when from gastric disturbance, is solitary, quite superficial, red in color, and seated near the tip of the tongue.

TREATMENT.—The treatment of dyspeptic ulcer is attended with much difficulty. The patient can rarely be induced to submit to that strict rule of self-denial which is absolutely essential to a cure. Under no other conditions can it be healed.

The cure necessitates abstinence from stimulants of every kind, and from the use of tobacco. The diet must consist of bread and milk, eggs, arrow-root, tapioca, and animal broths, avoiding the use of meats, aromatics, and condiments. Medicine is of little importance.

Syphilitic ulceration of the tongue appears in patches, is usually painless, increases slowly, and does not affect either the movements of the tongue or the articulation. It can be traced to venereal origin, and demands either mercury or the iodide of potassium, or both, for its cure.

Aphthous ulceration, or thrush, is met with both in children and in old persons. It is not limited to the tongue, but extends to the insides of the cheeks and gums. It appears as white flakes, or patches, resembling the curd of cheese, some of which remain distinct, while others become confluent. The subjacent ulcers are round or oval, surrounded with a red areola, and on the bottom of each is a gray, felt-like slough.

The true nature of the ulceration was first demonstrated by Gruby, in 1842, as depending on the presence of a fungus,—the *oidium albicans*. (Fig. 1576.) The spores meet with a congenial soil in the mouth, owing to the altered character of the secretions of the different glands which open into the cavity, and, attaching themselves to the papillæ of the tongue, grow into a forest of branching filaments.

FIG. 1576.



Oidium albicans.

TREATMENT.—When the disease appears in infants or children, the physician should institute a strict inquiry with reference to the food, and the cleanliness of the vessels in which it is administered. Nurses are often to blame for the existence of the ulceration, administering, either from want of judgment or from indifference, food unsuited to the stomach of the child, which creates flatulence and acidity. The correction of any evil from this source, the exhibition of a laxative of magnesia, and the internal administration of the chlorate of potash, with

a mouth-wash of the same, will soon effect a cure. In the aged it may be necessary, in addition to the use of washes of the chlorate of potash, or of carbolic acid, to adopt a general tonic plan of treatment, as the use of iron, quinine, and more particularly the mineral acids, with change of air.

Strumous, or Tubercular Ulcer.—This ulcer is met with in strumous and tuberculous subjects. Its seat is not at all regular, being sometimes located on the side of the tongue, at other times near the tip.

The disease commences in the mucous membrane, in the form of small granulations, which after a little time assume a dark appearance, with a yellow centre. When the granulations break down, the edges of the resulting ulcer are irregular, and its bottom is covered with minute granulations. There is also accompanying the sore a notable hypertrophy of the papillæ.

The treatment must be chiefly constitutional, comprising cod-liver oil and the iodide of iron, with a nutritious but unirritating diet. The ulcer can be touched with advantage every day with iodoform, less frequently with chromic acid, or it may be greatly benefited by being dusted with subnitrate of bismuth. In the case of a gentleman from California who was under my care, and who had two ulcers of this character, one healed under the last-named application, and the other, as I subsequently learned by letter, was slowly improving. These sores had been open for nearly two years.

Tumors of the Tongue.

The tumors which affect the tongue are *benign* and *malignant*.

The benign tumors are papilloma, angioma, cystoma, lipoma, fibroma, gum-mata, and the malignant carcinoma.

Benign Neoplasms.

Papillomata.—The lingual papillæ may become hypertrophied, dense, and horny, so as to form a papilloma, or wart. Mr. Hulke has recorded a notable

example of a patient who suffered from these growths on his tongue, and who was in the habit of paring them with a razor when they became too long. They are generally free from pain, and slow in their growth. Their attachment may be pedunculated or sessile. Excision is the best method of removing them.

Angeiomata.—Erectile or vascular tumors of the tongue are not very common. They are seen occasionally seated on the side and dorsum of the organ, or near its tip, and may be recognized by their soft, bluish appearance, and spongy feel. By pressure the blood can be pressed out of the vessels, leaving the swelling quite flaccid.

These growths can be treated by strangulation, by excision, by removal with the *écraseur* or the galvano-cautery, and by injection.

Strangulation by the ligature is a slow process, and not free from danger resulting from the swelling and from the introduction into the system of septic matters. In one case which was operated on at the clinic of the University by this method, the child was nearly suffocated by the swelling of the tongue, and was poisoned by the horrid discharges which exuded from the strangulated mass. When the growth is small, it is most quickly disposed of by excising it, and afterwards closing the wound with one or two sutures. When the tumor is larger, the wire or galvanic *écraseur* will do the work well. In a large *nævus* covering fully one half of one side of the tongue, which came under my care at the Hospital of the University, I succeeded in destroying the vascular structure, and converting it into a dense mass of fibrous tissue, by injecting into its substance, at five different times, seven or eight minims of the tincture of iodine. The interval between the injections varied from one to two months.

Cystomata.—Cysts in the tongue are quite unusual. They are generally due to the occlusion of the orifice of a lingual crypt or follicle, though they may arise from one of the intermuscular spaces of the organ. They are both superficial and deep, single and multiple. The tumors are usually spherical, the size of a small marble, and when they project from the surface, stretching the mucous membrane of the tongue, exhibit a dull, half-transparent appearance. Fig. 1577, taken from one of my patients, represents a cyst situated in the middle of the under surface of the tongue, near its tip.

Cystic tumors of the tongue can be laid open and the sac excised, or they may be opened, and the interior of the sac destroyed by cauterization with nitrate of silver, or by introducing a little ball of lint, and exciting suppuration. The first plan, or complete excision, is to be preferred when the operation is not attended with too great disturbance of the structure of the tongue.

Lipomata.—Fatty tumors of the tongue are exceedingly rare. I have never seen a growth of the kind, though a few instances are found in surgical writings.

Clarke notices one in the museum of the College of Surgeons, London, presented by Sir Astley Cooper, and another in the museum of Middlesex Hospital, and Liston refers to a similar one. Should the growth demand surgical treatment, the operation by excision would be proper.

Fibromata.—Fibrous tumors usually occupy the dorsum of the tongue, and lie nearer the posterior than the anterior extremity. They are firm, oblong, and fixed growths. They grow to the size of an almond before creating

FIG. 1577.



Lingual cyst.

much inconvenience. I removed one which had existed for several years from the tongue of a young man. The tongue should be dragged forward with a tenaculum or a vulsellum, and, while held in this position by an assistant, the growth should be seized in a pair of claw forceps, raised up, and excised by two elliptical excisions. Deep sutures are to be immediately introduced, which serve the double purpose of closing the wound and of arresting the hemorrhage.

Pedunculated fibromata, sometimes spoken of as polypi, are occasionally seen growing from the tongue. They appear to elect the posterior portion of the dorsum of the organ, just in front of the glosso-epiglottic folds, in which to develop. A young woman, under the care of Dr. William Hunt and myself, had a pedunculated tumor of this nature, the body of which was the size of a walnut, the pedicle being very short. It frequently occasioned symptoms of suffocation by falling over on the top of the larynx. It was removed by Dr. Hunt by passing a double ligature through the base and tying each half separately.

Enchondromata are the rarest of all growths of the tongue. With the exception of two cases, one occurring in the practice of Weber and the other in that of Velpeau, I know of none reported.

The treatment would be excision.

Gummata of the tongue are indolent, deep-seated, irregular tumors, never very prominent, and which, from their immovable nature, appear to be incorporated with the substance of the organ. They are usually free from pain, and possess neither the hardness of a fibroma nor the induration of a carcinoma. A syphilitic history can always be discovered. The tumor sometimes degenerates into an ulcer, which, from its hard, ragged edges and unhealthy discharge, might be mistaken for carcinoma. The possibility of a syphilitic ulcer being transformed into epithelioma is entertained by some writers. I have never seen anything in the history of either affection to corroborate such an opinion.

TREATMENT.—Gummata yield to antisyphilitic remedies, often leaving, after they disappear, a contracted cicatrix.

Malignant Neoplasms.

Carcinomata.—The epithelial form of cancer is that which in almost all cases is witnessed in the tongue, and is generally primary. Males are more subject to the disease than females. Of 72 cases which I have analyzed, 40 occurred in men and 32 in women. Age also exercises a marked influence in the development of the disease, the largest number of cases being met with between forty and fifty. In only one instance, that noticed by Humphrey, has the affection been seen as early as the fifth year.

Epitheliomata of the tongue are three times as frequent as all the other varieties of cancer which affect that organ.

The progress of the disease is remarkably rapid, few persons surviving over eighteen months, and many perishing in six months. Cancer of the tongue is usually seated on the side of the organ, rather behind than in front of its middle. It begins either as a ragged, hard knot, unyielding to pressure, with a substratum of induration, or as a small crack. Very soon after its appearance the mucous membrane surrounding the base of the knot begins to corrugate or pucker. With these peculiarities the infiltration may progress for a considerable time, with or without ulceration, the induration and enlargement tending to travel back rather than forward. The disease seldom transcends the median raphe of the organ, a fact which is probably referable to the mechanical obstacle offered by the septum of the tongue to the lateral diffusion of the cells rather than to the slight inosculation of the ranine

arteries. After a time an ulcer forms, having a hard, crisp, elevated and ragged margin, with surrounding induration. Soon a rank growth of foul granulations, covered with a fetid discharge, springs up, and is frequently followed by profuse hemorrhages from the vessels which open from time to time. The glands under the jaw and in the neck become contaminated and enlarge; severe neuralgic pains are experienced along the side of the temple and in the ear; the mouth becomes so obstructed by the increase in the growth that articulation and deglutition are accomplished with difficulty, and the pharynx is filled with tenacious mucus and saliva, requiring prolonged and repeated efforts for their dislodgment. During sleep the breathing is noisy; in consequence of the encroachment of the growth on the fauces and pharynx; the rest is broken, and disturbed with frightful dreams and starts; the strength and the flesh waste; the face assumes a sallow or waxy hue; and the hemorrhages grow more frequent, until at length the sufferer dies exhausted.

DIAGNOSIS.—Epithelioma of the tongue bears some resemblance to syphilitic ulceration, and by those not familiar with the two affections an error of diagnosis may be made. The distinction may be established with certainty by contrasting the individual characteristics.

EPITHELIOMATOUS ULCERATION.

Commences near the side, and generally behind the middle of the tongue.
Pain sharp, lancinating.
Movements of the tongue restricted.
Articulation imperfect.
Progress rapid.
Appears at or after middle life.
Induration precedes ulceration.
Fetor of discharges very offensive.
Not influenced by treatment.
Not necessarily any sign of syphilis.
Involvement of the lymph glands common.

SYPHILITIC ULCERATION.

May occur at any part of the organ, generally at the dorsum.
Little, if any, pain.
Movements unembarrassed.
Articulation perfect.
Progress slow.
Appears before middle life, as a rule.
Induration succeeds ulceration.
Fetor not necessarily present.
Improves under treatment.
Always traceable to a syphilitic origin.
Involvement of the lymph glands not common.

TREATMENT.—In a disease which runs its course with such remarkable rapidity, and which invariably returns after removal, the question naturally arises, Is it proper to recommend an operation?

When the induration has extended to the root of the organ, or when the floor of the mouth, or the lymph glands beneath the jaw, have become implicated, any operation contemplating the removal of the tongue is utterly useless, and should be unhesitatingly declined. It is in such cases that the operation of dividing the lingual nerve will prove useful by lessening the pain and the salivation. This nerve passes between the inferior maxillary bone and the internal pterygoid muscle, and enters the tongue just behind the submaxillary gland.

There are two ways of dividing the lingual nerve. The method of Hilton consists in incising the mucous membrane on the floor of the mouth, parallel with the jaw, and opposite to the second molar tooth, the tongue being at the same time drawn to the opposite side. The nerve may be seen immediately beneath, when it can be raised on a blunt hook and divided.

The other method is that of Moore, and may be adopted in the event of the floor of the mouth being involved in the disease. This operation is done farther back.

By passing a finger back along the inner side of the inferior maxillary bone, the alveolar ridge of the last molar tooth can be distinctly felt. The nerve lies behind and parallel with this ridge, between the latter and the anterior lateral half-arch of the soft palate. A line drawn from the middle of the crown of the last molar tooth to the angle of the jaw, on the inside, will cross the nerve about half an inch from the tooth. Accordingly, if the point of a curved bistoury is introduced through the mucous membrane, and pushed onward in the direction of this line to the distance of three-quarters of an inch, and is then turned with its edge to the bone, cutting directly down upon the latter, the nerve must be severed.

With a view to restrain hemorrhage and retard the growth of the disease by lessening the supply of blood to the organ, the lingual arteries have been tied. This operation, first recommended by Dumarquay in 1867, and practiced by Hilton and Moore, has also received the sanction of Coote, Hirschfeld, and Shrady. The procedure may temporarily check bleeding, but I doubt very much whether the patient will be materially benefited.

In cases of lingual cancer which come early under the notice of the surgeon, before the floor of the mouth or the glands of the neck have become implicated, and when the induration has not reached the region of the circumvallate papillæ, excision of the diseased part, or amputation of the entire organ, is a justifiable operation. Justifiable, I say,—not that a cure is to be looked for, but because the life of the patient will in all probability be prolonged.

In an analysis of 39 cases of cancer of the tongue by Clarke, 14 of which were treated by operation, the average duration from the commencement of the disease was found to be eighty-six weeks, one of the patients living six years, while in the remaining 25 who were the subjects of operation the average duration of life was about forty-two weeks, and the longest period of any one of the number, two years.

An operation being determined upon, what shall it be? This will depend on the extent of the disease to be removed.

When confined to a very limited part of the tongue, the partial removal of the organ may be all that is required; but when more extensive, the complete or entire ablation of the organ may be necessary. The means of carrying into effect the operation are the knife, the ligature, the *écraseur*, the galvano-cautery, and the thermo-cautery of Paquelin.

Knife.—When the disease is near the anterior extremity of the tongue, and its size does not exceed that of a quarter of a dollar, the knife is to be preferred.

The operation is not very painful, and can be done most conveniently without an anæsthetic, as the surgeon will have the co-operation of the patient's will; though, if the latter demurs, there is no serious objection to the use of ether.

The patient being seated on a reclining chair or on a table, with the head and shoulders elevated, a gag (Fig. 1578) is fixed between the molar teeth of one side, in order to keep the jaws asunder.

The tongue is then grasped with Museux forceps (Fig. 1579), dragged well out of the mouth, and given to an assistant to hold, when the surgeon, seizing the diseased part with a pair of claw forceps, removes it with a sharp-pointed bistoury by two incisions, one on each side, and meeting behind at an acute angle like the letter V.

Any vessels which bleed must be tied with the animal thread, after which the sides of the wound are to be brought together and secured by the interrupted sutures deeply inserted.

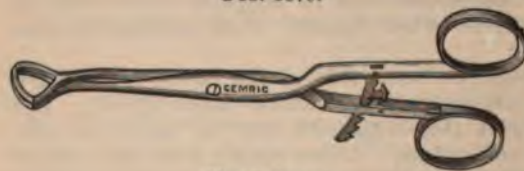
Ligature.—When the disease is more extensive, or when there is an appre-

FIG. 1578.



Gag for separating the jaws.

FIG. 1579.



Museux forceps.

hension of hemorrhage, the ligature may be substituted for the knife. The jaws being separated by the gag and the tongue drawn forward, two needles, armed with stout carbolized double threads, are to be passed through the sound tissue of the tongue, some distance beyond the disease, and the threads tied in such a manner as to invest or surround completely the affected part, as follows: supposing the cancer is located on the tongue a short distance behind its tip, one needle is carried through the organ from the under to the upper surface in front of the disease, and a second in the same manner behind. The silk threads being separated, the different ends are tied strongly together, as represented in Fig. 1580. In this way the growth is surrounded and the necessary strangulation is effected.



Operation by ligature.

The double ligature, after the plan of Erichsen, is also well suited for strangulation. A long thread, one half being dark-colored to distinguish it from the other half, is passed back and forth around the diseased tissue, after which the loops are to be divided, the white thread on one side and the dark one on the opposite side, and their ends tied together. (Fig. 1581.)



Strangulation by the double thread.

I have never been very favorable to strangulation by the ligature, as the swelling of the tongue which follows, and the presence of a decomposing mass of tissue in the mouth, are not free from danger to the patient.

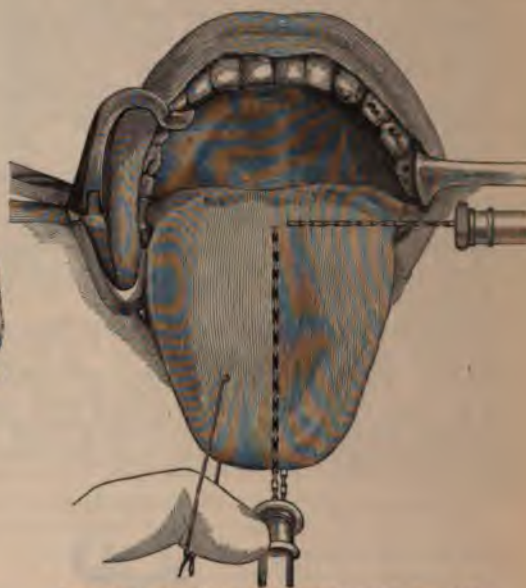
Écraseur.—There are three *écraseurs* which can be used in removing a part or the whole of the tongue,—that of Chassaignac, in which the chain loop is used; that with wires; and that connected with the electro-galvanic battery. Any one of these appliances will answer the purpose; but the galvano-cautery is particularly well adapted for the ablation, as it can be employed without loss of blood.

Operation by the écraseur.—When the disease admits of an *écraseur* being applied to the tongue through the mouth, the operation can be done in the following manner:

If the chain is used, let one of its extremities be secured to the eye of a probe with a loop of silk thread. Then, after dragging the tongue out of the mouth with the vulsellum, pass flatwise a sharp-pointed bistoury from the under to the upper surface of the organ through the median line. Guided by the blade of the knife, let the probe bearing the chain be passed through the wound, after which the bistoury is to be withdrawn, the chain pulled into position (Fig. 1582), and its ends made fast to the screw of the *écraseur*. Before commencing the process of crushing, one or two pins should be thrust into the tongue from below upward, coming out on the dorsum of the organ between the disease and the chain loop, so that the latter shall not, during the condensation of the tissues, slip forward into the unsound parts.

As soon as one side is severed, the loop of the instrument can be slipped over the other half, and its division effected in a similar manner. If only one-half of the tongue is to be removed, two *écraseurs* may be employed (Fig.

FIG. 1583.



Removing one-half of the tongue by two *écraseurs*; gag introduced.

FIG. 1582.



Chain and probe passed along the blade of the bistoury.

1583), and operated at the same time, their chains being introduced through the same opening.

In using the wire *écraseur*, the loop can be passed very quickly by introducing through the tongue a curved trocar and canula, and, upon withdrawing the latter, carrying the wire through the canal of the instrument, after which the canula can be removed.

Paquelin's thermo-cautery.—Three times I have removed portions of the tongue with the knife-shaped instrument of the thermo-cautery of Paquelin. In one instance the anterior lateral half was burned off in this manner; and in cases where the disease is limited to a small extent of the surface, and not far back on the organ, this cautery will be found to act well.

Total ablation of the tongue.—When it becomes necessary to extirpate the tongue in its entirety, the operation may be effected in four ways,—viz., oral, symphyseal, submental, and buccal.

Oral.—The oral method, or that of Paget, consists in separating the lateral and anterior attachments of the tongue to the jaw, by dividing the mucous membrane forming the floor of the mouth along the sides, and the mental origins of the genio-hyo-glossi muscles on each side of the symphysis of the lower jaw. When this has been done, the tongue can be drawn out of the mouth to an extent which will allow of the hook of the *écraseur* being slipped back to its root. Mr. Lund adopts the oral method by first getting the command of the tongue by means of a ligature passed through its substance and cutting away its attachments to the jaw and hyoid bone with the scissors, tying the vessels as they are divided.

Symphyseal ablation, or the method of Syme and of Sédillot, is performed by first dividing the lower lip in the median line, and carrying the incision down to the hyoid bone, and, after removing one of the middle incisors, sawing through the symphysis of the lower jaw.

The two halves of the bone being then drawn asunder, and using the finger

as a guide, the surgeon next divides the attachment of the mucous membrane along the floor of the mouth, and also the muscles which connect the tongue to the jaw, when the lingual arteries are exposed and tied. The tongue can now be cut away with a knife, securing any vessels which bleed, or its division may be accomplished by the *écraseur*. In one instance, after exposing the organ in this manner (Fig. 1584) and separating its attachments from the jaw, I threw around its base the wire loop of the galvano-cautery, and accomplished its bloodless separation in a few seconds.

After the excision has been completed, and all hemorrhage controlled, the two sides of the jaw are to be drilled and firmly wired together, the lip closed by the twisted sutures, and the wound in the neck by the interrupted stitch.

Submental.—There are two operations which may be included under this head,—that of Regnoli and that of Nunneley. Regnoli, who published his method in 1838, made two preliminary incisions below the chin, one parallel with the base of the jaw, stopping short on each side of the facial arteries, and the other from the middle of the first down to the hyoid bone. (Fig. 1585.) The two flaps thus formed are to be dissected back, exposing the muscles beneath, which are next to be severed from the jaw, namely, the

FIG. 1584.



Operation through the symphysis of the jaw.

FIG. 1585.



Line of incision in Regnoli's operation.

FIG. 1586.



Tongue drawn out in the submental operation of Regnoli.

anterior bellies of the digastrics, the mylo-hyoid, the genio-hyoids, and the genio-hyo-glossi. The mucous membrane of the mouth is next detached from the jaw with the finger, and divided with the knife anteriorly and laterally as far back as the external wound. The tongue is then seized with the vulsellum forceps, drawn through the external wound, and severed from its remaining connection, close to the epiglottis and the hyoid bone, either with the bistoury or with some form of the *écraseur*. (Fig. 1586.) After tying any vessels requiring the ligature, the external flaps are to be brought together by the interrupted suture, and dressed as an ordinary wound.

Nunneley's modification.—Nunneley, of Leeds, has simplified the submental approach to the tongue, by making a short incision in the median line of the neck, between the jaw and the hyoid bone, and continuing the dissection inward and upward between the genio-hyo-glossi muscles until the mucous

membrane of the mouth is reached at the frænum linguæ. This being punctured, the chain or wire of an *écraseur* is passed through the opening, slid back over the tongue to its root, and the division accomplished either by the screw or by the galvano-cautery, as may be most convenient. (Fig. 1587.)

Whitehead uses the scissors chiefly in removing the tongue, and Jacobson, in addition to employing scissors, often does a preliminary laryngotomy. The pharynx is plugged, to prevent blood from passing into the air-passage, and the tongue, being secured by a silk loop, is dragged forward and split longitudinally, each half being removed separately.

Buccal or Jordan's method.—By this plan an incision is carried from the circumference of the mouth on one side to the anterior border of the masseter muscle. The vessels being tied, the tongue is drawn strongly forward and transfixed by two pins, one entering on each side of the frænum, and emerging behind the circumvallate papillæ. The loop of the *écraseur* being now passed over the tongue and behind the pins, the division of the organ can be effected. (Fig. 1588.) This operation has been done by Gant with very satisfactory result, the patient remaining entirely well two years afterwards.

FIG. 1587.



Nunneley's modification for removing the tongue.

FIG. 1588.



Jordan's method of removing the tongue.

AFTER-TREATMENT.—After ablation of the tongue, the patient is liable to experience considerable difficulty in swallowing, in consequence of the inflammatory swelling. This is best relieved by allowing small bits of ice to be taken into the mouth, and by applying hot flaxseed-meal poultices to the outside of the throat. Should the swelling threaten to obstruct the opening into the glottis, leeches must be applied on the outside of the neck, below and behind the angles of the jaw, a brisk purge administered, and a febrifuge mixture, with a little morphine, given every two or three hours. When deglutition is extremely painful, the patient should be nourished for two or three days by injections of milk and beef-tea. The most agreeable and efficient mouth-wash is dilute listerine.

Mortality.—The mortality following the removal of the tongue, considering the magnitude of the operation, is very low. Of 76 cases which I have analyzed, only 10 died from causes justly attributable to the operation.

The least fatal operation appears to be that of Nunneley, whose experience and success seem to be exceptionally large, he having done the operation 19 times without a death. Billroth had 17 operations without a death. Butlin claims 10 per cent., and Barker 13 per cent., of permanent cures. No such success have I seen, however.

The operation I usually prefer is, after dragging the tongue well forward by a stout loop of thread, to pass a double ligature through its base and tie temporarily each side, thus controlling the bleeding, after which the tongue can be dissected from its connections with the scissors or knife. The dangers

incident to the operation are hemorrhage, exhaustion, pyæmia, œdema about the glottis, and pneumonia.

Effect on articulation.—It is remarkable that after the removal of the tongue many patients are able to articulate with a distinctness which renders them quite intelligible, corroborating in many particulars the wonderful stories which are told with reference to persons who have undergone this terrible mutilation. Clarke, who has gathered together much curious information on this subject from various sources, mentions the history given by Milman of the infliction of this punishment, by the order of a Vandal chief, on a number of Christians who resided at Tipasa, on the north coast of Africa, during the early part of the Christian era: they were afterwards able to speak so well that it was regarded as miraculous.

By a law of Louis IX. of France, blasphemers and perjurers were condemned to have the tongue burned out with a hot iron. Many French Protestants who underwent this mutilation on account of their religion were subsequently able to pronounce words distinctly; and it is asserted that speech returned to the emirs of Mount Lebanon after they had suffered the same punishment as a penalty for conspiring against their chief.

Diseases of the Gum, Teeth, and Jaws.

Hypertrophy of the Gums may be either a congenital or an acquired condition. When the former, it is for the most part associated with some defect in mental and also in physical development.

The hypertrophy is sometimes limited to the soft parts of the gums, being a hyperplasia of their normal tissues; at other times, in addition to the latter, there is an enlargement of the alveolar process. The disease may include the gums of both the upper and the lower jaw, or it may affect only a portion of the gum. The latter is usually the case when the subject is advanced in life. In typical cases of the disease, such as are given by Gross, Salter, Waterman, MacGillivray, Heath, and others, the hypertrophied gum projects as a pale or pink, inelastic, rough mass with surface indentations or mammillary eminences often overlapping the teeth (Fig. 1589), quite insensible to pressure, and giving rise to a very marked deformity.

When occurring in old persons, it is evidently due either to the irritation produced by chewing on the edentulous gums, or to the pressure of badly-fitting artificial teeth. In two instances I have seen an extensive hypertrophy arise from the latter cause, one in a man of forty and the other in a person of eighty.

TREATMENT.—The remedy for hypertrophy, whether congenital or not, whether occurring early in life or late, is excision. The growth may return, and require that the operation shall be repeated. In the cases which came under my own observation, the enlargement in the younger of the two patients required a second removal, which proved to be permanent.

Tumid Gums.—There are several enlargements of the gums which are caused by both local and general conditions of the system. Thus, there is a swelling limited to that portion of the gum between the teeth, particularly the incisors of the lower jaw, and due to the irritation of tartar, which accumulates about the necks of the teeth. There is also a swollen, spongy state of the gums, which is seen in scurvy and after certain low forms of fever. They have a dark red or leaden color, and bleed on being touched. A very singular instance of this condition of the gums I once saw in a young lady, following an injury to the spinal marrow, to which I have referred under the head of injuries to the spinal column and cord.

FIG. 1589.



Hypertrophy of the gums.

In treating cases which can be traced to local irritation, the removal of the irritant is of the first importance, after which, if the hypertrophy persists, the gums may be frequently penciled with an astringent application, as solution of nitrate of silver, tannic acid, or a very dilute preparation of the acid nitrate of mercury (one part of the acid to ten parts of water).

When the enlargement is referable to constitutional causes, iron and quinine, the mineral acids, with infusions of the bitter tonics, together with a varied diet and fresh air, will be required; should there be a scorbutic element in the affection, the vegetable acids will be indicated.

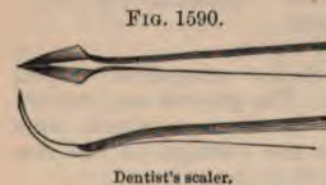
Mercurial swellings can be readily recognized by the swelling and tenderness of the gums, by the soreness felt on bringing the jaws together, and by the flow of saliva and the peculiar fetor of the secretions of the mouth.

The inflammation, when slight, is quite amenable to a mouth-wash of chlorate of potash or of borax. The fetor is best corrected by the use of a wash consisting of equal parts of rose-water and tincture of calendula, adding to each ounce of the mixture two grains of the permanganate of potash. In more severe cases of salivation, in addition to the local remedies already named, the internal employment of the iodide of potassium will be found of great value. When the teeth loosen and threaten to drop out, and the gums are in danger of sloughing, in addition to brushing the parts with the dilute tincture of iodine as advised by Garretson, or with salt and brandy, the system must be well supported by tonics, stimulants, and nutritious liquids.

Tartar.—The accumulation of this substance, though occurring chiefly as a crust or deposition on the inner surface of the teeth, produces serious injury to the gums, and may with propriety be discussed in this connection. It is a deposit from the fluid furnished by the salivary glands, and is very common in persons who suffer from disturbances of the digestive organs, and in those who are indifferent to the use of the tooth-brush. The teeth and gums which suffer most are the incisors of the lower jaw and the molars of the upper jaw, as these are most exposed to the undiluted saliva as it enters the mouth from the sublingual, submaxillary, and parotid glands. The depositions of tartar produce inflammation, softening, and even ulceration of the gums, and, entering the depressions around the necks of the teeth, eventually cause the latter to become loose, and even to drop out of their sockets.

A female patient on one occasion applied to me to have a hard tumor removed from the mouth, which was located between the under surface of the tongue and the inferior maxilla. It was completely covered with mucous membrane. On making a careful examination, a minute orifice was discovered on the surface of the enlargement, and on introducing a probe the instrument came in contact with a hard substance, which proved to be a salivary calculus which had gradually imbedded itself in the mucous membrane of the mouth, so as to become completely encapsulated.

TREATMENT.—When the tartar does not adhere tenaciously to the surface of the teeth and gums, it may be removed by the tooth-brush; but when this cannot be done, it will be necessary to detach the concretion by means of the



Dentist's scaler.

scaling instrument of the dentist. (Fig. 1590.) To prevent its re-accumulation, the teeth must be frequently cleansed by a proper tooth-powder applied with a soft brush.

Sloughing Ulcer.—The disease referred to by this term is not that sloughing which arises from the local or constitutional action of certain medicinal substances, as mercury, or substances employed in the arts, as phosphorus, but an ulcer which appears to depend for its existence on certain zymotic causes of too subtle a nature for detection.

Its subjects are children and the inmates of asylums. Occasionally it is

seen among children who are surrounded by unfavorable hygienic conditions. Under the latter circumstances I have seen a well-marked example of the disease in this city. It has been observed in the Children's Asylum of the Philadelphia Hospital. The disease commences as a dark red, livid, or pale spot at the scalloped border of the central incisors of the inferior maxillary. The spot darkens, and finally drops out as a slough, when this morbid action extends, often very slowly, to the adjacent portions of the gums. The discharges from the ulcer are sanious and offensive. The destructive process, if not controlled, extends beyond the limits of the gums, attacking the alveolar processes, the cheeks, and the lips.

TREATMENT.—When the affection makes its appearance in a public institution, the children should be removed to other quarters, and those laboring under the disease should be separated from the healthy. A wholesome nutritious diet must be provided, the mouth frequently and thoroughly mopped out with solutions of sulphate of iron, sulphate of copper, permanganate of potash, bromo-chloralum, tincture of the chloride of iron, or nitric acid, and iron and quinine, with milk-punch, administered internally.

Tumors of the Gums and Pulp-Cavities.

Under this heading I will describe several varieties of tumors dissimilar both in origin and in structure, including those morbid growths of the gums technically known as epulides, but which histologically may be classed under the different heads of fibromata, fibro-angiomas, papillomata, myo-fibromata, and epitheliomata.

1. **Fibrous Growths** are frequently seen arising from the gum between the teeth, or from other parts of its surface, and are often pedunculated in form. They consist chiefly of a hyperplasia in the connective-tissue element of the gum. (Fig. 1591.) Exposed to friction from hard substances in the food and in the use of the tooth-brush, these growths are liable to bleed and to become a source of annoyance and anxiety to the patient. Having no connection with the alveolus, it is sufficient for their cure that they be snipped off close to the gum, and the raw surface touched with a crayon of nitrate of silver.

Under the head of fibrous growths, though not strictly epulides, belong the pulp tumors.

Pulp tumors.—Two tumors of a fungoid nature are met with on the gum, which have their origin in the pulp of the tooth-cavity. The one, which is a hypertrophy of the connective tissue of the pulp, is quite devoid of sensibility; the other, from its inflammatory origin and its relation to the sound nerve-filaments of the alveolus and the pulp, is quite as remarkable for its extreme sensibility. Both find their way out of the central canal of the tooth, through an opening either in its side or in its crown. The first, or callous growth, is generally found in connection with teeth whose cavities have been exposed by caries; it assumes a pedunculated form, and, mushroom-like, spreads over the tooth and the gum. The second, or sensitive growth, has generally a more acute history; it will probably be found to follow a fracture of a tooth, and is developed by the sudden access of air, food, and other irritants to the dental cavity, causing inflammation of the pulp and the formation of a redundant or fungoid mass of granulation tissue.

FIG. 1591.



Fibrous tumor of the gum.

(Fig. 1592.) The sensibility of this latter growth is so great that the slightest touch causes excruciating suffering.

FIG. 1592.



Fungoid growths from the dental pulp.

DIAGNOSIS.—These pulp tumors are liable to be confounded with others of a more serious nature; but the diagnosis may be rendered certain by finding that the pedicles of the tumor can be traced into the cavity of the tooth.

TREATMENT.—Pulp tumors or enlargements can generally be cured without the sacrifice of the tooth. The affected portion of the tooth should be removed and the cavity filled.

2. **Fibro-Angeiomata.**—Fibro-vascular growths have two distinct origins,—one from the tissues of the gums, and the other from the pulp-cavity of a tooth. In the first, or external one, the relative proportion between the fibrous and the vascular elements varies. In some the vascular component

FIG. 1593.



Erectile tumor on the gum of the upper jaw.

is quite insignificant, while in others it preponderates to an extent which entitles the tumor to rank as an angioma, naevus, or erectile growth. Accordingly, we find such a growth appearing sometimes as a florid mass the size of a pea, projecting from between the teeth immediately above the apex of the scalloped borders of the gum, either on its anterior or its posterior face (Fig. 1593); at other times as a soft, compressible mass, generally on the anterior aspect of the gum,—preferably of the upper jaw,—having a faint blue or purple color, sensibly increased by excitement, and capable of being temporarily emptied of its contents by

pressure. The subjects of these tumors are generally children. Twice have I seen them develop at a later period of life.

The treatment of that form of the disease in which the fibrous element predominates does not differ materially from that proper in cases of true fibroma, and should consist in clipping away the neoplasm and cauterizing the raw surface left by its removal. There is a probability, however, of its return unless the incision is carried deep into the submucous connective tissue at its base. Much more serious is the management of the vascular, or erectile, variety of the disease. So intimate is the connection between its vessels and those of the bone, that nothing short of the excision of that part of the jaw covered by the growth will suffice for its eradication. In performing this operation, a preliminary incision should be carried around the tumor down to the bone and some distance beyond the limits of the disease, after which the piece can be cut away with strong bone pliers. If the incisions have been made sufficiently far into the sound bone, the hemorrhage, which at first is quite free, will soon subside. If not, a pledget wet with boiling water and then squeezed partially dry can be laid against the bleeding surface and will usually check the oozing.

In a very extensive case of angioma of the gum which I once saw, the tumor extending from the canine tooth to the tuberosity of the superior maxilla, the disease was cured by opening the cheek, dissecting away the growth from the jaw, and sealing up the vessels with the actual cautery. Only the slightest superficial exfoliation followed, and the teeth remained firmly in their sockets.

Papilloma of the Gum is a rare affection. It was first observed by Sir William Fergusson,* and afterwards described by Mr. Salter† as a white mass or growth made up of filiform and fungiform papillae. The remedy is excision.

* Lancet, September 6, 1862.

† Heath, Injuries and Diseases of the Jaws, p. 127, 2d ed.

Epithelioma may develop primarily on the gum, or it may extend to it from the lip or the cheek. The primary and secondary forms of the disease differ much in appearance. When commencing in the gum, the glands of the latter appear to be the seat of the morbid action; the tumor is covered by the unbroken mucous membrane, and has been described as a variety of myeloid sarcoma. When secondary, or reaching the gum from the lip, jaw, or cheek by tissue-continuity, it appears in the ulcerative form with an advancing line of induration.

No operation which does not include the removal of the bone some distance beyond the limits of the disease will offer any hope of a cure; and even when this is done in secondary epithelioma of the gum, the prospect of a cure is exceedingly doubtful. When the lymph glands under the jaw have become affected, no operation can afford relief.

Sarcoma, popularly termed *epulis*, is a firm, insensitive tumor, covered by mucous membrane, and seemingly growing from the posterior margin of the gum, or between the latter and the neck of the tooth. Frequently it appears to spring from between the teeth, and in most instances occupies the anterior in preference to the posterior face of the gum. (Fig. 1594.) These neoplasms vary in bulk from the size of a grain of wheat to that of a hickory-nut. The upper jaw is slightly oftener affected with the disease than the lower. Females suffer more frequently than males.

The disease is rarely seen in persons under ten or over sixty-five years of age, the largest number being met with between twenty and thirty-five. The presence of the teeth doubtless has much to do with the causation of the disease, as its occurrence in the edentulous jaw is quite exceptional. Two varieties of the affection exist, one of which is quite firm, and consists largely of parallel and intersecting connective-tissue fibres, with which occasionally are blended some osseous particles; the other is of much softer consistence, with less connective tissue, but containing embryonal marrow, or myeloid cells, and sometimes the giant polynucleated cells. This would be classified with the myeloplaxies by the French school of histologists.

The first or fibrous variety of the disease springs from the periosteum of the alveolus, while the second or softer form probably begins in the endosteum of the cancellated tissue of the alveolus. Not only is the structure of the latter rarefied and made porous, but, as the growth occupies the socket of the tooth, the cavity becomes enlarged and the tooth finally displaced.

TREATMENT.—These tumors, though possessing a tendency to recur, have only a local significance. They do not have the malignant properties of cancer, and are therefore incapable of producing a cachexia. When they have returned after operations done by myself, I have always believed it to be due, not to any element of malignancy residing in the growth, but to some fault of my own in being too conservative in the sacrifice of structure. The treatment, therefore, is clear: let the soft parts be divided down to the bone some distance beyond the limits of the tumor, and cut out along with the growth an equally extensive section of bone, and the cure will be assured.

Affections of the Teeth.

The wide range of sympathies exerted by the teeth through the reflex system, from the earliest period of dentition until the maxillæ become edentulous in old age, renders their diseases extremely important to the surgeon. Much of the gastric and intestinal irritability, convulsions, febrile perturbations, and skin eruptions of infantile life can be traced to disturbances in dentition. It is also true that in more mature life we meet with

FIG. 1594.



Epulis of the upper jaw.

abscess, caries, and necrosis of the jaws, cases of neuralgia of the face and of parts more remote, and of diseases of the eyes and ears, which can be traced to morbid states of the teeth. Though oral surgery has assumed the importance of a special department, no well-educated physician should be ignorant of the diseases which belong to this region of the body; and indeed no oral surgeon is competent to understand the problems of dentition, or to treat intelligently the morbid phenomena connected therewith, without having enjoyed the advantages of a thorough medical education.

Inflammation of Gums from Eruption of Teeth.—Although the inflammation is due to the advancing tooth or teeth, yet, inasmuch as the general and local symptoms depend on the resistance offered by the tissues of the gums, it will not be out of place to consider the subject in the present connection.

When the teeth are sufficiently advanced to render the restraint offered by the gum sensible to the little patient, it is indicated by a feeling of itching or discomfort, which causes the child to bite upon any hard substance within its reach. Often rubbing the gum with the finger will allay the restlessness incident to the irritation. After a time the epulic membrane becomes red, tender, swollen, and hot, the child is fretful, slaving, and feverish, and not unfrequently the reflex irritability is so increased as to give rise to diarrhoea or convulsions.

There are other cases in which all these symptoms may exist and yet the gum exhibit no signs of hyperæmia. This fact has suggested to Dr. J. W. White an explanation for the disturbances arising from primary dentition different from the one already given, namely, congestion of the dental pulp, caused by the backward pressure of the resisting gums upon the advancing tooth, thus interfering with its nervous and vascular supply. Two papers by him on the subject of pathological dentition, one in the *Philadelphia Medical Times*,* and the other in the American supplement to the *Obstetrical Journal of Great Britain*,† will amply repay a careful perusal.

TREATMENT.—The proper remedy for this inflammatory and painful condition of the gum is incision, commonly called "lancing." This simple operation should not be done prematurely. If performed too early, or before the tooth has sufficiently advanced, the wound is likely to heal before the eruption of the crown, and the resulting cicatrix will at first offer a more obstinate resistance to its progress than the original gum. No mistake need be committed, however, as the urgency of the symptoms, local or general, will serve to announce when the time has arrived for surgical interference.

The operation is done with the gum lancet. (Fig. 1595.) The child being

placed across the knees of the mother or nurse, with its face exposed to a good light, and its hands held, the operator, seated, takes its head between his knees, and, separating the lips, exposes the offending portion of the gum.

If over the incisors or cuspids, a single incision, parallel with the curve of the alveolus, and



FIG. 1595.

Gum lancet.

sufficiently deep to render sensible to the touch the contact of the blade with the underlying tooth, is all that will be required; but when the molars are to be released, it will be necessary to make a crucial division of the parts, so as to free the four cusps of the tooth.

With the lancing of the gums the local swelling and inflammation, and also the general febrility, usually disappear.

The bleeding which follows the operation rarely amounts to more than a few drops, but should it be profuse it will generally be referable to the hemorrhagic diathesis, and must receive early attention. The wound should be

* *Philadelphia Medical Times*, October 25, 1873.

† *Op. cit.*, 1873.

touched frequently with hot alum-water, Monsel's solution of iron, or a mixture of equal parts of turpentine, alcohol, and fluid extract of ergot. In urgent cases ergot may be administered internally, and, if necessary, the actual cautery applied to the bleeding surface.

Irregularity of the Teeth.—The most common anomaly during second dentition is irregularity of the teeth. They are sometimes crowded together in such a manner that the regularity of the dental arch is broken, one or several of the teeth assuming an oblique position and their surfaces overlapping. The difficulty arises from an asymmetrical development of the teeth in relation to the alveolar process of the jaw. The remedy consists in the judicious removal of certain teeth, generally one or both bicuspids on each side.

There are instances, again, of irregularity, particularly in the teeth of the lower jaw, when the deformity is only slight. The tendency to self-correction which is usually present will generally, in time, remedy the evil, and the case may therefore be wisely left to natural forces.

When a tooth persists in maintaining its vicious position in defiance of the laws of developmental correction, an effort must be made to rectify the error. Much may be done by systematic pressure, made frequently every day with the fingers, pushing the offending tooth in a direction not only opposite to the displacement, but also outward in the long axis of the jaw, so as to increase the alveolar accommodation. If two adjoining teeth, as the central incisors of the upper jaw, are crowded out of line, (Fig. 1596), the traction must be applied in opposite directions. While the jaws are in process of development, it is astonishing how much may be accomplished by the unaided efforts of the individual.

FIG. 1596.



Vicious positions of the central incisors.

FIG. 1597.



Correcting a misplaced incisor by mooring it to a bicuspid with an elastic band.

FIG. 1598.



Plate with silk cords adjusted, to draw incisors into position.

There are other cases of dental irregularity, where, in consequence of the solid articulation of the teeth, and the consolidation of the maxilla, nothing

short of mechanical measures will answer to restore to place an erring member of the dental arch. Among these measures is the adjustment of a metal or rubber band (Fig. 1597), or of a plate against the hard palate, to which traction cords can be attached. (Fig. 1598.) These are cases which require the mechanical skill of the dentist.

In all these operations for rectifying vicious dental positions, especially in young subjects, whether by traction, bands, or wedges, the tendency in the teeth to become loose under the force must not be overlooked, and this requires that the treatment be from time to time interrupted.

Dental Denudation and Abrasion are terms used to express the gradual destruction of the enamel of the teeth, in consequence of which they become grooved on the anterior or labial surface, or suffer a progressive loss of substance on the cutting or grinding surfaces.

The incisors are most frequently affected, though all of the teeth may undergo a like change. The denudation may commence immediately above the necks of the teeth by a softening of the enamel, leaving a well-defined groove. Discoloration is frequently associated with denudation. In order to prevent the exposure of the pulp, nature, coincident with the progress of the lesion, throws out a deposit of new bone, filling the pulp-cavities of the affected teeth.

The cause of denudation is very imperfectly understood, but it is usually either hereditary, or, when acquired, is due to some defect in the function of digestion. Mr. Bridgman believes that it is often due to electro-chemical agencies; and this view receives the qualified sanction of Garretson. Peculiarities in the articulation of the maxillæ constitute a mechanical cause quite sufficient to explain in many cases the occurrence of abrasion limited to the grinding or cutting surfaces of one or more teeth. I have specimens in my collection of crania which place this beyond cavil.

TREATMENT.—When the enamel has, under these agencies, disappeared from the surface of the teeth near to their necks, the depressions should be filled with gold; when the anterior teeth suffer the process of shortening, it can be retarded by fitting metal caps to the molars in order to lessen the attrition of those affected.

Dislocation.—A tooth may be loosened from its articulation, or even entirely displaced, by a blow. It should be immediately readjusted or inserted again into the socket, and the jaws bound together until readhesion has been contracted. If done promptly and accurately, this may be expected to follow, even though some short time has elapsed before it has been replaced. One of my medical friends had a large molar extracted, plugged, and afterwards re-inserted. A skillful dentist of this city performed a similar operation with such success that the tooth has now been doing good service for over two years.

Fracture.—A tooth broken off transversely through the crown, as may happen from a fall or a blow in which the violence is received in front, will not again unite. Even when broken below the neck, or when fractured vertically, it is not possible to secure consolidation of the fragments. But when the teeth are not fractured, though torn from the sockets and carrying with them portions of the alveolar walls and of the soft tissues, a successful reposition is possible. Their careful replacement and retention in position by binding the jaws together will generally result in a satisfactory union. It is in such injuries that the services of a dentist will prove valuable in constructing caps by which the retention of the pieces will be rendered more secure. It has happened that the same force which fractures a tooth inflicts a like injury on the jaw, and when the latter lesion passes through the alveolus belonging to the broken tooth, the union of the jaw may be defeated by a root of the injured tooth dropping between the fragments. This hap-

pened in a case of Mr. Erichsen, and entirely defeated the consolidation until the root was discovered and extracted.

Dental Caries is an erosion of the dental tissues, commencing in the enamel and extending to other portions of the tooth. It begins in a spot or speck of discolored enamel, which after a time softens, breaks away, and leaves an irregular cavity (Fig. 1599), which continues to enlarge. Unless its progress is arrested, the entire crown is destroyed. The roots remain, and resist for a long time the destructive process.

CAUSATION.—The causes which operate to produce caries of the teeth have been a fruitful subject of discussion among dental pathologists. The teeth are often incorrectly considered as having a mechanical rather than a vital connection with the body, and as being removed from the influence of those general conditions which affect other portions of the human system. If, on the contrary, the teeth are regarded as an integral part of the vital unit, subject to the same disturbances of nutrition as other members of the body, it is not difficult to understand the exceedingly common prevalence of dental caries, especially among Americans.

Look at the Irish and Scotch peasants, and see what white and spotless teeth these races possess, as compared with the defective teeth which belong to the men and women of Philadelphia or any other American city. It is not a matter of surprise that American dentists have no equals in the world, for where is there such a field for the cultivation of the art as in this country? The chief cause, therefore, of dental caries is not extremes of temperature, carelessness with regard to cleanliness, the use of sweets, etc. All these may exert some influence; but the chief of all causes is one as general as the system at large, and is the product of all those agencies which go to make up the structure of modern social life, including eating, drinking, sleeping, exercise, and education.

These, too, leave the teeth vulnerable to external irritants which otherwise would prove harmless.

TREATMENT.—This must be prophylactic and operative. The prophylactic treatment will include the use of plain, substantial food, avoidance of alcoholic stimulants, exercise in the open air, proper hours for rest, and the use of the toothpick, the tooth-brush, and antacid mouth-washes,—none being better than a pure article of palm soap, which should be used immediately after each meal, as only in this way can the crevices of the teeth be freed from those particles of food which through fermentation become the source of destructive acids. The operative treatment comes within the province of the dental surgeon, and consists in cutting away the diseased tissue until that which is sound is reached, and then filling the cavity with a plug of gold, when the tooth may be preserved for a long period.

Necrosis.—Whatever tends to destroy both the vascular pulp and the connection of the tooth with the periodontal membrane must necessarily produce necrosis or death of the tooth, as from these two sources is derived its supply of blood. The death of the pulp alone does not produce necrosis, although a tooth with a devitalized pulp is frequently miscalled a dead tooth. Necrosis may be caused by mercury, by the fumes of phosphorus, by scurvy and syphilis, by blows, by a diffused deposition of bone in the body of the tooth, and by serious interference with vital functions by the various cachexias.

The death of a tooth is accompanied by a general brown or dark discoloration of its body, which is often preceded by inflammation of an acute or a chronic form, followed by suppuration. Whenever the signs of local irritation begin to develop, the tooth should be extracted, as otherwise the inflammation may extend to the jaw and cause serious trouble. In aged persons it is not uncommon to see the teeth loosen and fall out of their sockets

FIG. 1599.



Caries of a tooth.

without any suffering being experienced. Generally in such cases there is a loss of vascularity, the effect of senile atrophy, which involves the gum, periodontal membrane, alveolus, and pulp, in consequence of which the parts shrink away from the necks and roots and allow the tooth to escape. Necrosis affects the tooth in its totality, and, once commenced, we have no means to arrest its progress.

Alveolo-dental Abscess, or Gum-Boil.—Alveolar abscess is seated around or at the extremity of one or more of the roots of a tooth. It is often the result of a neglected or uncontrolled inflammation of the periodontal membrane. It is also one of the effects of caries, or may be developed by a tooth being crowded in the jaw or by exposure to cold.

The symptoms which attend the disease are often of a character calculated to mislead the inexperienced practitioner. There is a swelling of the cheek and of the gum, with tenderness and pain in the jaw, not unfrequently attended with a paroxysm of fever. The pathology of the disease consists in an inflammatory deposition of lymph beneath the periodontal membrane, separating the latter from its connection with the root and transforming it into a sac. There is also a partial disintegration of the end of the root, and between the latter and the thickened membrane is the cavity which contains the pus. (Fig. 1600.)

An alveolar abscess finds its way through the wall of the alveolus, and may point immediately external to the affected cavity between the jaw and the reflected mucous membrane, forming a protrusion of the latter over the gum.

In other cases, the tissues of the cheek become glued to the maxillæ, and the abscess points on the surface of the face. There are cases in which the communication between the cavity of the abscess and its opening on the surface has a very long and circuitous course, terminating in the nasal fossa, particularly when an incisor of the upper jaw or a canine is affected. When originating at the roots of a premolar or a molar, it may follow the hard palate to the fauces, and, if commencing in a tooth of the lower jaw, will not unfrequently enter the neck.

TREATMENT.—During the acute inflammatory stage of an alveolo-dental abscess, it is possible to abort the disease by unloading the congested vessels of the gum by free scarifications, followed by a purge, and, after its operation, the administration of from two to ten grains of Dover's powder, according to the age of the patient. When no amelioration of the symptoms follows, our efforts must be directed to the rapid maturation of the abscess and its evacuation at a favorable point. With this object in view, a little bag filled with powdered slippery elm and dipped occasionally in hot water may be worn with advantage between the cheek and the gum,—never on the outside of the face, as it is not desirable to invite the abscess in that direction. Frequent rinsing of the mouth with water alone, as hot as can be borne, will conduce to the same end. As soon as the abscess furnishes a hint as to pointing, it should be immediately laid open, so that it may not seek the external surface.

There is a stage in the history of an alveolar abscess—just as the acute symptoms begin to wane—when, if a little opening is drilled through the external wall of the alveolus, the sac may be tapped, the pus evacuated, and much suffering avoided.

An alveolar abscess once formed opens the way for subsequent trouble, and suggests the propriety of removing the affected tooth. The exception would be when the subject is young and the final dentition not completed, in which case even imperfect teeth contribute to the expansion of the jaw.

Difficult Eruption of the Wisdom-Teeth.—The most alarming symptoms often follow the eruption of a wisdom-tooth. The difficulty is a mechanical

FIG. 1600.



Alveolar abscess at the extremity of the root.

one. The other molars occupy so large a portion of the alveolus that the wisdom-tooth, when it begins to emerge from the jaw, is so crowded back towards the root of the coronoid process of the maxilla that it becomes changed in direction, and its complete eruption is prevented. The effect of this resistance is to develop inflammation of the gum, which is often preceded by a period of soreness in the jaw, not suspected for a time to be connected with the tooth. In aggravated cases the inflammation extends back to the lateral half-arches, to the periosteum of the jaw, and to the soft tissue at the base of the tonsils, terminating in suppuration, the abscesses often extending into the neck. In the mean time the patient suffers severe pain, with stiffness of the jaws, in consequence of the spasmodic contraction of the masseter muscle, and experiences great difficulty in deglutition.

TREATMENT.—In simple cases, even though the eruption is tardy, if the symptoms are not urgent, it may suffice to make free crucial incisions across the crown of the tooth and wait for its emergence. But, when there is evidence of the inflammatory action becoming diffused, I have seen so much evil result from temporizing that I have no hesitation in advising the immediate extraction of the tooth. It will sometimes be found difficult to get the jaws sufficiently wide apart to gain access to the tooth; but, by administering ether, and prying the maxillæ asunder, the forceps can be carried sufficiently far back for its removal.

Dental Fistula.—After the evacuation of an alveolo-dental abscess, a fistulous track may remain which refuses to heal. The external orifice may be on the gum, near the alveolus in which the abscess originated; or it may be at some point over the hard palate, or on the surface of the cheek, should the abscess have opened originally in these situations. In cases of this kind, the irritant which maintains the fistulous canal may be found to be the root of a tooth, or possibly a necrosed fragment of the alveolus; occasionally the circuitous route of the fistula, or the almost incessant action of the muscles of the face, prevents healing. By introducing a probe through the fistulous track the length of the passage can be ascertained, and also the presence of diseased bone, if any such exists.

TREATMENT.—If the tooth or any portion of its roots remains in the socket in which the abscess originated, they must be removed at once. This will, in most cases, put an end to the fistula. If, notwithstanding, the latter persists, the fistulous track should be laid open in its entire extent, and made to granulate from beneath. When the external opening is in the face, and it refuses to heal after the removal of all detectable causes of the fistula, the cheek must be detached from the adjacent parts, the edges of the opening freshened, and its sides brought together by the twisted or the interrupted suture.

Odontalgia.—Toothache depends upon a variety of conditions, which, to be properly treated, must be clearly understood.

First. The most common cause of this painful affection is dental caries, leaving the sensitive pulp exposed not only to the action of the products of bone-decomposition, but to various kinds of external irritation, as air, particles of food, and the different secretions of the mouth. Careful and skilful examination is frequently required to detect the carious cavity, especially when it is located upon laterally opposing surfaces.

Second. The death and decomposition of the dental pulp constitute another cause of toothache, and one which often provokes, in addition, severe neuralgia of one or more of the branches of the fifth pair of nerves. This is attributable to the confinement of mephitic gas consequent upon pulp-putrescence producing mechanical pressure. If unrelieved, it eventuates in acute alveolo-dental periostitis terminating in abscess. In this condition the tooth will be tender to pressure, and the gum unusually red, sensitive, and possibly swollen.

Third. Shrinking of the gums, leaving exposed that portion of the tooth which is most vulnerable to external agencies, namely, the cementum with its periosteum, is not an uncommon cause of odontalgia. This recession of the gum-tissues from the neck of the tooth is often the result of a consolidation of the cementum, which disturbs the vital connection between the gum and the tooth, inducing atrophy of the former. When a deposition of new bone occurs at the bottom of the alveolus, which may be simultaneous with that on the peripheral part of the root, the tooth is raised in the socket at the same time that the gum recedes from the neck.

Fourth. Granular ossification of the dental pulp is another cause of toothache, and one very difficult of detection, as there are no local signs which betray the changes going on within the pulp-cavity.

Fifth. Various affections of the jaws, as osteitis, necrosis, osteoma, or cystoma, by inflammatory irritation extending to the pulp, or by pressure on the dental nerves, will occasion severe attacks of odontalgia. Cases of the disease referable to causes of this kind are usually apparent, not only from the coexistence of disease of the maxillæ, but from the character of the pain, which is seldom confined to a single tooth, and is more continuous than ordinary toothache.

Sixth. Odontalgia is sometimes the result of reflex irritation, traceable to sources distant from the seat of pain. In this manner we may account for the toothache which occasionally accompanies disorder of the stomach. The dental apparatus being a part of the digestive, the two have not only a physiological but also an anatomical connection through nervous communications. Again, pain in one tooth will, in the same way, excite pain in a corresponding tooth on the opposite side, or in several teeth, which are without any evidence of being unsound. Women during gestation frequently are annoyed with odontalgia, which disappears after parturition.

Gout and rheumatism may likewise occasion odontalgia, in consequence of impressions made on branches of the fifth pair of nerves by the products of mal-assimilation, which in these affections are not entirely eliminated.

The young suffer more frequently from toothache than persons in middle or advanced life.

The pain of odontalgia is intense, throbbing, often radiating along the branches of the trigeminus to the different portions of the jaw and face, and not unfrequently to the ear and eye, and always aggravated by the recumbent position. In other instances the pain, instead of being acute, is dull and boring, worrying the patient with its constancy, and frequently accompanied with some swelling of the cheek. This variety is quite common in cases where the attack is brought on by exposure to cold, periosteal inflammation, or gastric irritation.

TREATMENT.—The treatment of odontalgia is palliative or radical, and must be determined by the nature of the offending cause.

The palliative treatment will embrace the correction, by acid or alkaline washes, of any defective reaction in the secretions of the mouth, and the removal, in the event of a cavity existing in the tooth, of any irritating substances.

When caused by exposure or near exposure of the pulp, direct applications to the cavity of decay will generally abate the pain. Among the best of the remedies are acetate of morphia (made into a paste with creasote, oil of cloves, or glycerin), oil of cloves, creasote, carbolic acid, laudanum, and tincture of aconite. A dossil of cotton should be moistened with one of these agents and inserted without pressure into the cavity of the tooth, and covered with a little wad of cotton to hold it in place.

Dr. Garretson extols the use of a solution of sulphate of atropia in cases which are not associated with inflammation of the dental tissues or of the surrounding parts, of the strength of six grains of the alkaloid to one ounce of water, and applied in the same way as the remedies already designated. The poisonous character of the drug, however, renders it unsuitable for gen-

eral use, and it should be employed only under the immediate supervision of the physician.

The patient should be directed, after the insertion of any of the more powerful agents, not to swallow the saliva for a time.

When the trouble is located in the periosteum, the measures best calculated to afford relief are the scarification of the gums when they are swollen and inflamed, the tincture of camphor or of hamamelis held in the mouth, the frequent use as a mouth-wash of water as hot as can be borne, which may be medicated by adding to it a few drops of laudanum, and a spice plaster worn over the cheek or between the cheek and gum over the affected tooth.

To these palliative resources may be added, when there are symptoms of gastric disorder or of cold, the administration of a saline purge, followed by a hot bath on going to bed, and a dose of spiritus Mindereri to which may be added an amount of morphia suited to the age of the patient.

When the toothache is due to death of the dental pulp or to its granular ossification, the remedy lies either in the extraction of the tooth, or, what is better, in drilling an opening into the pulp-cavity, either through the wall of the tooth, or through the cavity of decay if one exists.

The radical treatment of odontalgia requires either the sacrifice of the tooth, the cure of abscess, or the devitalization of the pulp, and filling the remaining cavity with a suitable plug. This can be done only by one familiar with the duties of operative dentistry.

Extraction.—The extraction of a tooth is a very delicate operation, and demands both manual skill and scientific judgment. Carelessness in this respect has too often resulted in irreparable damage to the jaw and has been followed by extensive abscesses of the neck.

Circumstances demanding extraction.—The reduction of the food to a state suitable for insalivation is so important a factor in the work of digestion, that no tooth ought to be sacrificed which can be safely preserved. I shall, accordingly, name those conditions which usually doom a tooth to extraction:

1st. When its body has been so extensively destroyed by caries as to leave only a shell so thin as to be unequal to sustaining the pressure of a filling, or when one or more of its roots remain in the socket and cause irritation.

2d. Teeth from the cavities of which grow fungous excrescences, sometimes called polypi of the pulp.

3d. Teeth in a jaw overcrowded.

4th. Teeth with alveolar abscess not otherwise curable.

5th. Wisdom-teeth which threaten to cause abscess.

6th. Teeth which have become hopelessly loose either from traumatic or other causes.

7th. Teeth which, in consequence of osseous tumors or ossification of the dental pulp, give rise to facial neuralgia.

8th. Teeth which, from their vicious position in the dental arch, so change the bearing of the crowns of the others as to cause their surfaces to grind away.

Instruments.—In order to remove a tooth properly from its socket, it is necessary to have instruments adapted to the anatomical conformation of its surface; or, what amounts to the same thing, to the class to which it belongs.

The incisor teeth, having a bicuneiform shape, the bases of the wedges going within the grasp of the gum, require an instrument the jaws of which will adapt themselves to a portion of both the alveolar and crown planes of the wedge, in order that it may not slip when the force is applied. The forceps represented in Figs. 1601, 1602, 1603, and 1604 furnish the best examples of instruments suited to the extraction of the incisors of the upper or lower jaw.

For removing an upper or lower bicuspid, or a canine, the forceps shown in Figs. 1605, 1606, and 1607 are valuable.

For extracting the molar teeth of the upper and lower jaw, Figs. 1608 and 1609 furnish the best patterns.

FIG. 1601.



FIG. 1602.



Forceps for extracting upper incisors.

The old instrument for removing teeth, which consisted of a semicircular key attached to a shank with a handle, has, very properly, fallen into desuetude.

FIG. 1603.



Forceps for extracting lower incisors or bicusps either side.

FIG. 1604.



Forceps for extracting lower incisors.

FIG. 1605.



Forceps for upper bicusps or canines.

As the tissues of the gum through the periodontal membrane are closely con-

nected with the neck and root of the tooth, these should be freely separated

FIG. 1606.



Forceps for extracting bicusps and canines of either jaw.

FIG. 1607.



Forceps for extracting lower bicusps.

from the latter, preliminary to extraction, by means of the gum lancet. (See Fig. 1595.)

The pain which accompanies the extraction of a tooth firmly imbedded in

FIG. 1608.



FIG. 1609.



Forceps for extracting molars.

its alveolus is of the most intense character, and, if of long continuance, would be unbearable.

The extraction of teeth, however, has been deprived of all its terrors by the use of anæsthetics, which should not be withheld unless at the special request of the patient. The operation being usually a brief one, nitrous oxide gas should have the preference over all others. When chloroform is given, the patient must occupy the recumbent position.

Local anæsthesia is sometimes practiced in order to lower the sensibility of the parts concerned in extraction. It is induced usually by agents which, by rapidly abstracting the heat of the gum and the jaw, render the nerves partially insensible to painful impressions. With this object in view, the parts may be surrounded with a thin gum bag or bladder containing a mixture of ice and salt, or they may be subjected to the action of a spray of ether or rhigolene, applied by means of the ordinary hand or foot apparatus. (Fig. 1610.)

OPERATION.—If the operation is done at the office of the dentist, the patient occupies a chair with a high back and head-rest, purposely constructed for dental manipulations, and behind which the operator stands,



Spray apparatus.

supporting the head of the patient between one hand and the side of his body, while with the other he holds the extracting forceps. When the operation is performed in the office of the general practitioner, or at the house of the patient, the latter should be seated on a low chair, and his head supported either by an assistant standing behind, or by the physician, who takes it between his arm and body. The gum being then freely divided, the operator seizes the tooth between the jaws of the forceps, close on a level with the alveolus, and proceeds to remove it from the jaw, by first using the instrument as a lever in which it is carried alternately inward and outward, combined, in the case of the incisor teeth lodged in a round conical pit, with a movement of rotation, in order to break the articulation between the root and the socket, when it becomes loose; after which traction is applied by which the tooth is lifted from the alveolus. The process is in all respects analogous to that by which one extracts a nail that has been driven into a piece of board, by forcing it backward and forward until it becomes loose, and then by pulling it directly out.

In extracting molar teeth with roots which widely diverge, the articulation with the alveolus may be broken, first on one side and then on the other, before applying traction. This manœuvre will conduce to the safety of the jaw.

In removing a wisdom-tooth which has only a single root, and which is crowded back towards the ramus of the jaw by the neighboring molar, it should be moved backward before making traction, in order not to endanger the solidity of the adjacent tooth.

Teeth are sometimes broken off during attempts at extraction, leaving the roots in the alveolus, or all above the latter may have been previously destroyed by caries, the roots alone remaining in the sockets. The extraction of such roots requires instruments of a different form from those ordinarily employed in removing entire teeth. For this purpose forceps with a thin, narrow beak (Fig. 1611), which can be slipped down between the root and the sides of the socket, will be required.

Sometimes when difficulty is experienced in obtaining command of the root, in consequence of failing to get the forceps down, it may be removed

FIG. 1611.



Narrow-bladed forceps for extracting roots.

by means of the screw elevator. (Fig. 1612.) This instrument, after being bored into the central cavity of the stump until it acquires a good hold, is to be drawn upon until the root is extracted.

FIG. 1612.

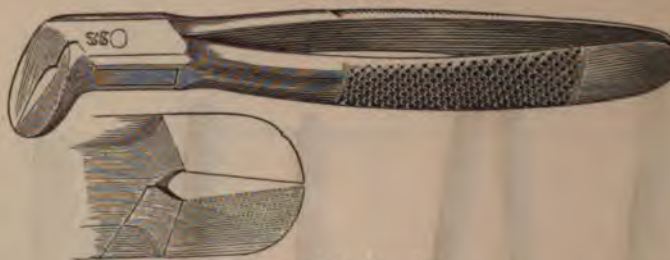


Screws for extracting roots.

Another plan of extracting these roots, especially those belonging to molar teeth and which refuse to yield to ordinary measures, is to divide them in half by the cutting pliers (Fig. 1613), when they may be removed, each piece separately, by the ordinary root forceps.

Accidents following extraction.—In removing a tooth, the roots may be

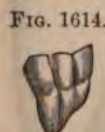
FIG. 1613.



Cutting and elevating pliers.

very divergent, or there may be some malformation, such as fusion of the roots (Fig. 1614), so that a portion of the alveolus is broken away.

When only a small fragment is detached, the accident is seldom followed by any evil; but where the injury has been more extensive I have seen a wide-spread necrosis of the jaw follow. When the connection between the fragment and the alveolus is not entirely destroyed, it should be replaced and given a chance to regain connection with the bone; but if too completely detached to render such a result probable, it will be best to clip away any slight attachments which remain and remove it.



Fusion of the roots of teeth.

Hemorrhage.—There is always, after the extraction of a tooth, a brisk flow of blood; but this generally ceases after a few minutes. Occasionally, however, cases are encountered in which a very alarming hemorrhage follows the operation. There is probably, in most instances of this nature, a pre-existing hemorrhagic diathesis. I have seen dangerous bleedings after extraction in persons with mitral disease of the heart or with Bright's disease.

In treating a case of alveolar hemorrhage, the cavity from which the tooth has been extracted should be thoroughly mopped out and inspected, in order to discover the source whence the blood proceeds. If from a single point, it is probably limited to a small artery, and may be at once checked by sharpening a piece of soft pine wood to a fine point and thrusting it into the aperture through which the blood issues. When the oozing is general, or from several points, the socket must be firmly plugged with a piece of sponge previously well saturated in a hot solution of alum or Monsel's salt, and kept in place by making pressure with the finger or by an interdental compress, and allowed to remain for several days. In the event of these means proving abortive, resort may be had to the actual cautery. Nor must general treatment be overlooked in these cases of obstinate hemorrhage. The patient should remain quiet, and constitutional hæmostatics should be administered, as ergot, turpentine, acetate of lead, opium, and tannic acid. Garretson speaks very favorably of the use of the tincture of *erigeron Canadensis*, given in one-drop doses every minute. In otherwise uncontrollable alveolar hemorrhage after extraction of teeth, it might be supposed that trephining the jaw, exposing the dental canal, and applying pressure to the inferior dental artery—when the bleeding comes from an alveolus of the lower jaw—would control the flow; or, in case the trouble was in the socket of a tooth belonging to the upper maxilla, the circulation might be commanded by ligating the internal maxillary. If the hemorrhage arose from constitutional idiosyncrasy, the danger would probably be increased, as the incisions necessary to carry into effect either operation would only furnish another surface for bleeding.

Sir Benjamin Brodie, in a case of this kind of hemorrhage, once tied the primitive carotid, but without any permanent benefit, the patient finally perishing from the loss of blood.

Odontomes and Tooth Tumors.

There are two general kinds of tumors connected with the teeth, which may be designated by the terms *hard* and *soft*.

Hard Tumors.

Enamel Nodules.—Portions of enamel are occasionally seen out of place, and, instead of being on the crown of the tooth, are found attached to the root. (Fig. 1615.) They are regarded by Mr. Salter, by whom they have been described, as cusps which have failed to reach the surface. They are found, on section, to consist of a nodule of dentine incrustated with enamel. The condition is not likely to give rise to any symptom requiring operative treatment.

FIG. 1615.



Enamel nodule.

Hypertrophy.—A tooth may undergo great enlargement of its roots, causing absorption of the walls of the alveolus in order to accommodate the increase in its bulk. A remarkable specimen of the disease, figured in the cut (Fig. 1616), is contained in the museum of the Philadelphia Dental College.

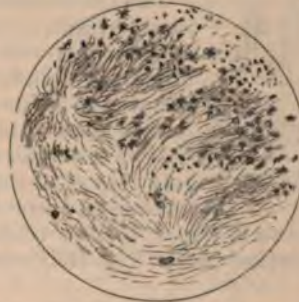
These tumors consist of dentine covered with cementum, the pulp being

FIG. 1616.



Hypertrophy of a tooth with enamel nodule.

FIG. 1617.



Microscopic section of hypertrophied tooth.

also greatly enlarged, and sometimes calcified. The microscopic appearances in a properly prepared section (Fig. 1617) are characteristic of both bone and dentine. Extraction would be the proper remedy in a case of the kind.

Exostosis is the name employed to express an enlargement of the root of a tooth, due to a disorderly outgrowth of the cementum. The effect of such

FIG. 1618.



Bony tumor attached to a molar tooth.

FIG. 1619.



Section of the same.

a mass at the bottom of the alveolus, raising the tooth, expanding the walls of the socket, and encroaching, as it must, on the dental nerves, is to produce,

at first, a general neuralgia of the face, which finally becomes more localized, and may be traced to the offending tooth by its extreme sensitiveness, and by the pain starting from its root.

FIG. 1620.



Tumor springing from dental pulp.—From specimen in the museum of the University of Pennsylvania.

There is another variety of exostosis which is connected with the dentine, consisting in an outgrowth from the latter, projecting into the pulp-cavity of the tooth, and which gives rise to symptoms not unlike those of external exostosis. (Figs. 1618, 1619.) A third variety of exostosis was at one time supposed to be an outgrowth from the cementum, but, from later observations made by Mr. Tomes, would appear to originate in the dental pulp. Fig. 1620 is an example of such a tumor. The proper remedy is the extraction of the tooth.

Dentigerous Cysts.

Cysts connected with the teeth are quite frequently met with, and are dependent on certain morbid changes which take place about their roots. The disease is not limited to either maxilla or to any class of teeth, affecting the incisors, cuspids, bicusps, and molars. The canine and the molars appear to suffer more than the other teeth, and in almost all instances the permanent rather than the temporary ones. The exceptions to this rule are few. Mr. Salter and Mr. Cartwright have each seen one case in which the cyst contained a temporary tooth.

FIG. 1621.



Molar having its crown between the roots of its neighbor.—From specimen in University.

The immediate cause of the disease is the presence of some local irritant, not always easy of appreciation when the cyst is connected with the roots of teeth perfectly developed, but doubtless of inflammatory origin, as caries or chronic periodontitis. In one case of my own, the disease had an antecedent history of alveolar abscesses, and I have reason to believe that the wall of the old abscess became transformed into that of the cyst.

In most instances the irritant is an undeveloped or a displaced tooth, which, having taken a wrong direction, or become entangled with another tooth (Fig. 1621), fails to reach the surface, and creates a disturbance in the tissues of the jaw, resulting in the formation of a cyst. (Fig. 1622.)

FIG. 1622.



Cyst of the jaw from a displaced tooth, laid open; walls of the jaw exposed.

According to Mr. Tomes, the formation of these cysts does not depend on any defect in the form of the tooth, but results from an accumulation of fluid in its encapsulating membrane, which, in consequence of eruption not taking place, remains unbroken.

As the dentigerous cyst increases in size, the alveolus and jaw undergo great changes. If the sac is merely connected with the root of the tooth, the alveolus becomes gradually absorbed as the cyst increases in size, in order to make room for its accommodation. The external enlargement of the bone in these cases often does not bear any proportion to the size of the cavity within. When the disease is due to an

proportion to the size of the cavity within. When the disease is due to an

undeveloped or wandering tooth, the irritation causes a diffused osteitis, which may involve a very large portion of the maxilla, producing simultaneous absorption or rarefaction of its interior cancellated tissue, and an expansion of the external or compact walls of the bones. (See Figs. 1624, 1625.)

Even when the disease appears to be localized, as far as can be known from the external manifestations, the rarefying process may be silently at work some distance from the apparent seat of the cyst. In the case of a lady whom I treated for a dentigerous cyst of the lower jaw, this condition was strikingly illustrated. Before I saw her she had had two cysts, appearing at intervals, I believe, of about one year,—one near to the angle of the maxilla in the position of the wisdom-tooth, which, from what I could learn, had been the cause of the disease; the second was about midway between the angle and the anterior dental foramen. These had been operated on, and, apparently, with success. The cyst for which she consulted me was between the anterior dental foramen and the symphysis of the jaw, and had expanded the bone in all directions so as to form a voluminous tumor. The external wall was cut away freely, and the case seemed likely to do well. One year later the husband of the lady called to consult me with reference to her case. She was then residing in the South. The disease was developing again towards the angle of the jaw, and manifesting a tendency to repeat itself. I advised the extirpation of the right half of the jaw, which was done with permanent success.

When occupying the upper jaw, dentigerous cysts may open into the antrum. Professor Baum saw one case in which both antra were occupied by cysts, in one of which was a canine and in the other a molar tooth.

The interiors of cysts originating from undeveloped permanent teeth are rarely single cavities, but are divided into several incomplete and irregular chambers by bony septa, and resemble in appearance the frontal sinuses. These cavities are occupied by a glairy fluid, sometimes quite transparent, occasionally purulent. The subject of dentigerous cysts has received the attention of a number of writers, among whom may be mentioned Dupuytren, Stanley, Paget, Heath, Salter, Fischer, Baum, Tames, and Jourdain.

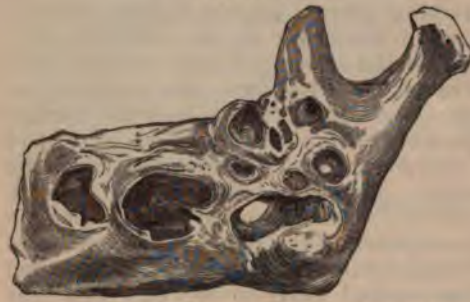
The diagnosis of a dentigerous cyst must necessarily be a matter of some difficulty. In a swelling of the jaw suspected to be of this nature, it has been suggested to examine the teeth, and if one of the permanent teeth is absent, or a temporary one is found occupying the place of a permanent one, it will furnish grounds for believing the tumor to be of this character. Importance is also attached to the parchment-like crackling which is felt when the walls of the cyst become so attenuated as to yield or become flexible under pressure. In the two cases which I have seen, this symptom was not present. Besides, it is well known that the secondary changes which sometimes follow the formation of a cyst of this kind render the tumor hard and unyielding. The surgeon will be compelled, therefore, to rely, when other means fail, on exploratory openings.

When the cyst is the result of a misplaced or undeveloped tooth, it should be opened, whenever possible, through the mouth, dividing the mucous membrane and the bone, either with a strong cartilage-knife or by the chisel and bone forceps, cutting away enough of the wall to expose the cavity of the tumor and allow the contents to escape. After this the interior of the cyst should be washed out with a solution of permanganate of potash, and afterwards mopped with tincture of iodine, stuffed lightly with lint, and its sides pressed together in order to diminish the space between them. Suppuration will follow, and the cavity finally becomes obliterated by ossifying granulations.

Dr. Warren, of Boston, would restrict the operation to simply puncturing the cyst, and, after the escape of its contents, forcing the walls together, and occasionally injecting through a crevice stimulating liquids in order to favor ossification.

When the bone has become extensively disorganized, nothing short of its removal will effect a radical cure.

The lower jaw is occasionally the seat of a polycystic disease, which, there is every reason to believe, is due to some irritation connected with the dental tissues, though no supernumerary or bent teeth may be found imprisoned in the bone. The most remarkable features of this affection are the multilocular caverns which are hollowed out of the maxilla at the expense of the cancellated tissue, and the extent of bone involved. (Fig. 1623.)



Multilocular cystoma, provoked by a misplaced molar tooth.

In time a multilocular cyst may become, by the more or less perfect absorption of the intermediate septa, a unilocular cyst, as in Mr. O'Shaughnessy's* case; and the same change seems to

have been in progress in the case illustrated above.

The treatment of polycystic disease of the maxilla must be conducted on the same principles as that of the more simple forms of the disease, by opening the cyst and breaking down the partitions, stimulating the interior with tincture of iodine, and, after inserting a slight packing, pressing the walls of the cavity together.

When the disease is extensive and refuses to yield to these milder measures, it will be necessary to excise the diseased bone.

Solid Dentigerous Tumors, or Dentigerous Osteomata.—These tumors, the odontomata of Broca, sometimes called warty tumors, are peculiar to the lower jaw. They begin primarily in some irritation connected with dental development, as in most instances they are found to contain the remains of dental tissues. The different structures of the teeth are commingled in a disorderly manner, forming numerous nodules or masses, which are thought

FIG. 1624.



Dentigerous osteoma.

to represent many separate tooth-germs which have failed to reach the surface. The disease may be so general as to obliterate all traces of a tooth,

* O'Shaughnessy's Diseases of the Jaw.

of which the specimen of Mr. Forget is an excellent example (Figs. 1624, 1625); or it may involve only a portion of its structure, as shown in Figs. 1626 and 1627, or in the case of Dr. Goodwillie (Fig. 1626).

These tumors are uncommon. Heath has been unable to collect more than five, namely, one by Ondet, in 1809, one by Fergusson,* one by Forget†, a

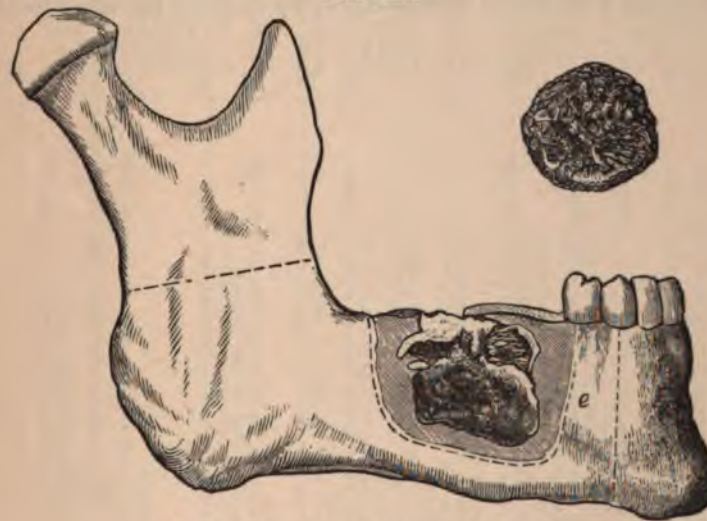
FIG. 1625.



Section of the same tumor occupying the place of the two absent molars.

fourth by Harrison,‡ and a fifth case reported in Hirden and Wedl's Atlas.§ To these may now be added that of Goodwillie, making six cases in all.

FIG. 1626.



Localized dentigerous osteoma, removed by operation.

TREATMENT.—When the disease, as in Goodwillie's case, is limited, it may be cut away with chisel and saw; but when it implicates a considerable part

* Tomes's Dental Surgery.

† Dental Review, 1860.

‡ Proceedings of the Odontological Society of Great Britain, December, 1862.

§ Atlas zur Pathologie d. Zähne.

of the jaw, as in Forget's case, it will be necessary to remove the maxilla to the extent of the tumor.

There are other tumors of the jaw which are formed by a tooth being

FIG. 1627.



Section showing microscopically the chaotic disposition of dental structures.

turned out of its course and remaining buried in the same portion of the alveolus; or it may finally cause the absorption of the bone, and become lodged beneath the bone and the mucous membrane, sometimes entering the antrum and even the hard palate.

Errors of this kind can be corrected only by excising the stray tooth.

Dentigerous Cysts.

No.	Sex and Age.	History and Description.	Duration.	Teeth Inclosed.	Operation.	Result.	Reference.
1	F., 17.	Large cyst expanding into antrum, with great dilatation of body of bone.	Months.	First and second permanent right upper molars, inverted.			Jourdain, Holmes's Surg., 2d ed., 1875, vol. iv, p. 365.
2	M., 60.	Cyst size of pigeon's egg, closing the nostril.	Many months.	Second upper premolar, deeply impacted.			Jourdain, Holmes's Surg., 2d ed., 1875, vol. iv, p. 365.
3	F., 13.	Tumor of intermaxillary bone (side not stated).	One year.	Monstrous permanent lateral incisor imbedded in intermaxillary, above and behind the central incisor.			Jourdain, Holmes's Surg., 2d ed., 1875, vol. iv, p. 365.
4	M., young.	Great swelling in substance of upper jaw; first and second permanent molars never appeared; antrum involved.		First and second permanent molars, inverted.	Free opening; serous contents.		B. Cooper, Holmes's Surg., 2d ed., 1875, vol. iv, p. 365.
5	F., 38.	Each antrum dilated by cyst; purulent fluid.	30 years.	Right canine; left molar.			Prof. Baum, Holmes's Surg., 2d ed., vol. iv, p. 366.
6	M., young.	Exostosis from upper jaw, combined with bony cyst, containing a temporary tooth.		Second temporary upper molar.			Edwards, Holmes's Surg., 2d ed., 1875, vol. iv, p. 366.
7	M., 22.	Cystic tumor size of English walnut; painless; gradual growth on outside of lower jaw.	3 years.	Lower canine; root adherent to lining membrane.	Two-thirds of wall removed; membrane vascular and thick; contents glairy.	Complete recovery.	Earle, Stanley, Dis. of Bones, 1849, p. 269.
8	F., 13.	Large tumor in cheek; nostril closed; palate depressed; nose pressed to opposite side.		Canine lying in bottom of cavity.	Proved a cyst by puncture; freely continuous; serous contents.		Gensoule, Stanley, Dis. of Bones, p. 286.
9	F., young.	Serous cyst of left upper jaw, size of pigeon's egg; teeth this side carious, and at times painful.		Left upper canine, transverse and very long.	Distinct from antrum; opened within the mouth; compression.	Recovery.	Bordenave, Sydenham Soc. Trans. (Boston Med. and Surg. Jour., N. S., vol. viii, p. 165).
10	F., 31.	Swelling, pain, and toothache after blow upon nose; tooth removed and not relieved; true nature not known before the operation; large tumor.	4 months.	Right upper lateral incisor and canine; old roots of temporary set remaining.	Tumor removed entire; contained yellow fluid and crown of lateral incisor; second cavity with canine behind this lined with crystallized earthy matter.	Recovery.	Syme, Edinburgh Med. and Surg. Jour., 1838, vol. i, p. 381.
11	F., 16.	Cyst around second lower molar, which appeared normal; finally became displaced and loose.	9 months.	Crown of third lower molar in a cavity in root of lower tooth.	Tapped twice, after which serous contents became purulent; tooth extracted.	Rapid recovery.	Tomes, Dental Surg., p. 204.
12	F., 30.	Tumor as large as hen's egg.	10 years.	Right third molar; root inverted and fixed in coronoid process.	Half of jaw removed.	Recovery.	(Heath, Dis. of Jaw, p. 372.)
13	M., 56.	Swelling in lower jaw opening behind front tooth; serous discharge.	2 years.	Canine at bottom; horizontally.	Sawed through jaw at two points; piece removed.	Recovery.	Lefranc, reported by Forget, Heath, Dis. of Jaw, p. 162.
14	M., 22.	Tense elastic swelling; had been punctured within and without cheek previously; serum escaped.		Third left lower molar impacted in socket of second.	Extracted second molar, which ruptured cyst and serum liberated; its root was greatly absorbed, and third molar exposed, being impacted in its socket.	Complete recovery.	Maisonneuve, op. cit., p. 164. Salter, Guy's Hosp. Rep., 3d Series, vol. v, p. 326.

Dentigerous Cysts.—(Continued.)

No.	Sex and Age.	History and Description.	Duration.	Teeth involved.	Operation.	Result.	Reference.
15	F., 18.	Had normal number of teeth, but left central incisor was of temporary set.	.....	Crown of permanent incisor projecting into cyst; root aborted; direction normal.	Both temporary and permanent incisors removed.	.....	Cock and Salter, Guy's Hosp. Rep., 2d Series, vol. v. p. 325.
16	M., 40.	Cyst size of pigeon's egg; contained thick, dark-yellow serum, and many cholesterol plates.	.....	Left second bicuspid, impacted.	.....	.....	Salter, Holmes's Surg., op. cit., p. 366.
17	F., 26.	Dilatation of outer wall of lower jaw; serous contents.	2 years.	Tooth at bottom of cyst.	Opened cyst within mouth, and portion of its wall removed; also tooth.	Recovery.	Poland, Guy's Hosp. Rep., 3d Series, vol. xv. p. 255.
18	M., 6.	Serous cyst on left side, encroaching on orbit and mouth, and projecting forward.	3 years.	Left upper lateral incisor, inverted.	Opened anterior wall and made window in superior maxilla; tooth removed.	Rapid recovery.	Bryant, Practice of Surg., 1872, p. 278.
19	F., 17.	Right upper canine deficient; cystic tumor.	.....	Right upper permanent canine.	Exposed cavity and removed the tooth.	Recovery.	Bryant, Practice of Surg., 1872, p. 278.
20	F., 8.	Nearly solid bony tumor of right upper jaw.	.....	Malplaced tooth growing from posterior part of orbital plate of bone.	Entire upper jaw removed.	.....	Bryant, Practice of Surg., 1872, p. 279.
21	M., 14.	Expansion of lower jaw as large as English walnut; thought to be solid.	5 months.	Second right lower bicuspid; root aborted.	External incision along the bone; sawing parallel with bone, opened a cyst and removed tooth; lining membrane thickened and vascular.	Complete recovery in 26 days.	Wormald, Lancet, 1850, vol. i. p. 756.
22	F., 13.	Ossous growth of left antrum; contained incisor tooth.	.....	One of incisor teeth.	Greater part of left superior maxilla removed; single incision through upper lip.	Recovery; very little deformity.	Ferguson, Med. Times and Gaz., Sept. 3, 1859, p. 229.
23	F., 13.	Large, hard tumor of entire left side of lower jaw; teeth had been extracted; cystic; thought to be solid.	6 months.	Left lower canine, projecting obliquely from floor of cyst.	External incision; jaw divided at symphysis, and left half disarticulated; fetid pus.	Recovery.	Fearn, Brit. Med. Jour., Aug. 27, 1864, p. 241.
24	M., 10 to 12.	Cyst large as Hickory-nut, incising secondary teeth; contained thin, watery fluid; discharged in mouth; afterwards discharging a second cyst, containing the corresponding right tooth, afterwards appeared.	.....	Second lower premolars.	Second temporary molar removed, and cyst widely opened; roots of the molar projecting into it; bicuspid at the bottom; position good; not disturbed; the second cyst similarly treated.	Recovery; both premolars took their place in the mouth.	Cheever, Boston Med. and Surg. Jour., N. S., vol. viii. p. 166.
25	F., 70.	Cyst in angle of jaw; had opened through the cheek, forming a sinus, which closed occasionally; supposed to be incisors; fluid purulent.	10 years.	Third lower molar very large; one stout quadrangular root.	Exposed through cheek; its tooth found lying across the cavity and removed.	Recovery.	Thorndike, Boston Med. and Surg. Jour., N. S., vol. viii. p. 166.
26	M., 40.	Very large tumor of right half of lower jaw, extending from second premolar nearly to tip of articular process; at first painless, but afterwards subject to very distressing inflamed swellings, which lasted a week or two; said to have followed the extraction of a tooth; second and third molars of this side absent.	8 to 10 years.	Second molar oblique and nearly under the first incisor; the division of the cyst; third cannot be found; the network of clefts without mutilating the preparation.	Portion of jaw behind first right premolar removed; cyst multiple bony, last covered with many rough bony granules, varying from $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter; there is one larger than the rest behind the first molar, indicating the place of the missing tooth.	Recovery.	Thorndike, Boston Med. and Surg. Jour., N. S., vol. viii. p. 166.

27	M., 17.	First noticed, when as large as a bean, behind lower left first permanent molar; since has gradually grown, until now it reaches from articular process to canine; greatest enlargement external; hard; no pain; second and third molars of this side absent; also second premolar (probably pulled); other teeth normal; principal complaint, of deformity and impaired motion of jaw; fluid serous.	2 years.	Second molar lying in outer wall of cyst, attached by its side, up right, perfect, but far from its proper place; third in angle of jaw, facing the cyst; not prominent; has no fang.	Reports two teeth to have been removed from this side one year ago, "which were succeeded by others;" jaw sawn through socket of left lateral incisor, and left half disarticulated; walls of cyst are bony, except a large membranous spot behind first molar, where the second and third should have appeared.	Recovery in 3 weeks so as to chew meat; deformity very slight.	Thorndike, Boston Med. and Surg. Jour., N. S., vol. viii, p. 166.
28	M., 14 (negro).	Left upper canine wanting; tumor extended into antrum; painless.	2½ years.	Left upper permanent canine firmly imbedded and growing from nasal process of superior maxilla.	Punctured, and glairy fluid escaped; single straight incision through upper lip into nostril; exposed cyst and excised anterior wall with saw and forceps; cavity contained thick, gelatinous substance, and canine tooth projecting from above; was sound and fully developed.	Recovery.	McCoy, of Sierra Leone, West Africa, Lancet, Aug. 19, 1871, p. 299.
29	F., 18.	Cystic tumor, right upper jaw; temporary tooth had been extracted.	3 years.	Right upper permanent canine tooth, with fang surrounded by bone.	No external incision; punctured with gouge; opening enlarged with forceps; contained serum.	Recovery.	Stocks, Brit. Med. Jour., July 10, 1875, p. 45.
30	M., 4.	Very hard tumor of left upper jaw; no pain; slow.	.....	"Displaced tooth."	Triangular section of upper jaw from inside of mouth, using bone forceps.	Recovery.	Jackson, Brit. Med. Jour., Oct. 6, 1877, p. 470.
31	M., 34.	Large hard tumor of lower jaw, with a yielding part.	9 years.	Right lower bicuspid, with perfect crown and two small fangs.	Punctured cyst; was hollow; in two weeks crushed cyst-walls; it extended between the two tables of bone; inner table of jaw and teeth unimpaired; no tooth felt; pieces of bone separated by suppuration, and one month later tooth found at bottom of cavity.	Recovery.	Heath, Lancet, Dec. 21, 1879, p. 877.
<i>History, Description, etc.</i>							
32		Capsule of bone as large as an English chestnut, probably having been filled with serum, rising from floor of antrum, and standing out free in its cavity; one loose supernumerary tooth within; no external deformity; no history.					Cartwright, Guy's Hosp. Rep., vol. v, p. 328, 81 Series (Salter).
33		Portion of lower jaw, which had been removed, containing a canine tooth, lying horizontally in floor of a large cavity in the bone; no further history.					Town, op. cit., p. 191.
34		An osseous cyst in palatal process of left upper maxilla, separating its compact laminae, caused by an inverted canine, which had curved upon itself, and now projects into the cavity, with its root pointed out to the alveolar process; cavity thrice the volume of the tooth.					Holmes, Surg. and Dent. Med. and Surg. Journ., op. cit.
35		Dr. Forget gives a case of a woman about 30, with a hemispherical tumor of right side of lower jaw; upon whom Nélaton operated, exposing tumor; made a hole in the outer wall, and found a tooth projecting into the cyst, undoubtedly a molar; the tooth was removed, followed by perfect recovery.					Nélaton, Heath, op. cit., p. 166.
36		Bottini reports a case, in a woman aged 23, of subperiosteal and subcapsular disarticulation of left side of lower jaw, for what proved to be a dentigerous cyst in connection with the wisdom-tooth.					Bottini, Heath, op. cit., p. 164.

It will be seen from an analysis of the preceding table that the teeth most commonly found displaced are the molars, 14 of the 36 belonging to this class; next in frequency are the canine, 12 in number; next the incisors, 5 in number; and last the bicuspid, 3 in number. Eighteen of the patients were females, 15 males, and in 3 the sex is not stated. The youngest was four years, and the eldest seventy years old. The result of operation is given in 22 instances, in all of which recovery followed.

DISEASES AND INJURIES OF THE JAWS.

The upper and lower maxillæ are very unlike, in their anatomical structure, their relations, and their functions. The upper jaw, in addition to bearing its part in the work of mastication in common with the lower jaw, contributes to the formation of the orbits, the nasal cavity, the mouth, the palate, and the tear-duct, besides containing a large cavity for the maxillary sinus or antrum. The lower jaw is chiefly concerned in mastication. In consequence of these functional differences, the diseases of the maxillæ, as well as their liability to morbid processes, are very unlike, the upper jaw suffering much more frequently than the lower.

Diseases of the Lower Jaw.

Deformities.—Most of the deformities of the lower jaw are acquired, and are either produced by pathological causes or result from some vicious habit.

Among the former, the cicatricial contraction which follows burns or scalds is the most common. In the young, the power of inodular tissue in producing this kind of distortion is very marked. When the cicatrix is situated beneath the chin, the anterior part of the jaw becomes gradually bent downward, and when it is disposed obliquely from the chin to the side of the neck, in time a noticeable change in the direction of the symphysis menti takes place. Tumors occupying the parotid region, when they attain a large size, not only change the direction of the jaw, but even alter the shape of its ramus.

In extreme cases of hypertrophy of the tongue, the weight of the organ hanging from the mouth will cause both elongation and bending of the anterior portion of the jaw. Irregularities of the teeth, by bringing in apposition only limited portions of the dental arches, will also change the direction of the jaw, so as to alter the expression of the face.

The treatment necessary to remedy these deformities consists in removing, as far as possible, the determining cause: therefore plastic operations are indicated in cases of burns, extirpations for tumors, amputation of the redundant part of the tongue in hypertrophy, and correction of the vicious teeth in cases of dental irregularities, either by mechanical means or by extraction.

The influence of certain habits of childhood, as sucking the thumb, on the shape of the lower jaw, causing deformity of the bone, has been particularly noticed by Mr. Vasey.* I have not seen among American children—with whom the practice is by no means uncommon—anything answering to the deformities described by Mr. Vasey and by Dr. Ballard, the latter of whom has had his attention attracted to the kindred habit of tongue-sucking.

There is a congenital deformity of the inferior jaw which consists in a departure from the proper angle between the ramus and the body of the bone, which, becoming too obtuse, produces an unnatural elongation of the chin, in some respects not unlike that peculiar to the aged jaw.

The use of an occipito-mental bandage, and the acquirement of the habit of supporting the chin on the hand when sitting, will contribute to the correction of the deformity.

Anchylous of the Jaw.—Though the term anchylous is usually employed to express rigidity or stiffness incident to changes connected with the articu-

* Transactions of the London Pathological Society, vol. xxvii.

lations, I shall use it here in a broader and more general sense, as expressive of all closures of the jaws, whether from reflex or pathological causes.

Reflex ankylosis.—Among the reflex or spasmodic causes is the irritation attending the eruption of wisdom-teeth, which acts through the connections between the sensory and motor branches of the fifth pair of nerves, exciting spasm or rigidity in the masseter, pterygoid, and temporal muscles. I have seen patients suffer from this cause for two weeks, unable to open the mouth more than was necessary to admit liquids. Cases of this kind can only be relieved by administering ether and extracting either the offending tooth or a molar to give it room.

Mumps will sometimes provoke a similar though less pronounced rigidity of the jaw, as the latter cannot be depressed without pressing against the swollen and tender glands. The stiffness disappears with the subsidence of the disease, for which time only is required. A like condition may follow the presence of a tumor in the parotid region. Acute tonsillitis will also excite reflex spasm of the muscles of mastication, for the relief of which the practitioner must rely on antiphlogistic remedies addressed to the affected glands.

Irritation of the upper spinal nerves from injury to the vertebræ constitutes another source of reflex spasm of the jaw. The following case is in point:

A machinist consulted me on account of spasmodic contraction of the muscles of mastication, rendering him unable to separate the jaws except for a short distance. This condition, which had existed for several months, came on gradually after a fall which he received by the upsetting of his wagon, in which he struck on the side of his head and neck. The neck was also stiff, and great soreness was complained of when pressure was made along the sides of the cervical vertebræ, or when an attempt was made to turn the head, which was always accompanied by a like movement of the body.

Under reflex ankylosis also come tetanus and trismus. I have known the latter to follow the extraction of a tooth in a patient of a highly irritable nervous organization. This condition yields to a warm bath and opiates.

Pathological ankylosis.—In this form of rigidity or immobility there has been some alteration of structure, either in the tissues of the mouth and the cheek, or in the components of the temporo-maxillary articulation. The worst cases of ankylosis from the former cause which I have ever witnessed were those which had been produced by the reckless use of mercury. Excessive ptyalism was often followed by extensive sloughing of the gums, cheeks, muscles, and even, to some extent, of the maxillæ, leaving, instead, a dense cicatricial tissue, which, contracting with age, entailed a rigid and immovable state of the jaw, seriously interfering with both mastication and articulation. The condition is rendered still more distressing when the cheek has been destroyed, leaving the teeth and jaws exposed, and allowing the saliva to dribble constantly over the face and neck.

Rheumatoid arthritis of the temporo-maxillary articulation will cause ankylosis by the fibrous and bony deposits which occur in and around the joints. Most of these cases of osseous bridges which pass between the upper and lower maxillæ, and which resist all movement of the jaw, are attributable to this disease. Inflammatory attacks, both traumatic and idiopathic, of one of the masseter muscles or of the articulation, constitute another source of stiffness or immobility of the jaw.

Finally, abscesses under the temporal fascia or fractures of the zygomatic arch with depression, by provoking irritation and inflammation of the temporal muscle, will induce a similar condition.

TREATMENT.—After no small experience in the treatment of ankylosis from pathological causes, I feel compelled to state that the results in my hands have been exceedingly unsatisfactory; and, so far as I have been able to observe, no better results have been obtained by other surgeons. Where the case is one in which the soft parts have been destroyed by sloughing, it

is possible, by dissecting away the cicatricial tissue and prizing the jaws apart, to obtain some temporary relief by improving the mobility. But this is of such short duration that, unless the inodular tissue can be replaced with sound mucous membrane or with skin,—which is rarely possible,—it is useless to subject the patient to an operation of such severity, as the reformation of the intractable material is certain to take place, and to increase rather than lessen the immobility. Occasionally, when the commissure of the mouth is gone, or the side of the cheek partially lost, the defect may be remedied by a plastic operation, or, in very slight cases, by dissecting up the remnants of the cheeks from the jaws, and, after freshening their edges, bringing them together with interrupted or twisted sutures, when union may be obtained.

By the aid of an intelligent dentist it is sometimes possible to obviate the inconvenience resulting from the opening in the side of the cheek by constructing a rubber or metal drain or obturator for closing the gap.

An operation devised by Esmarch will, in some of the severer cases of ankylosis following sloughing, not only increase the space between the jaws, but restore considerable movement. This consists in cutting out a wedge-shaped piece from the maxilla, in advance of the cicatricial tissue, and establishing an artificial joint. This can be done by making a small opening in the soft parts along the base of the jaw, and, after exposing the latter, excising from a quarter to half an inch of the bone, either with the Hey or a chain saw.

Simple division of the maxilla, as practiced by Rizzoli, with strong cutting pliers on the inside, has this disadvantage,—that it cannot always prevent the reunion of the bone. Cutting through the bone and securing a false joint is equally well adapted to cases of immobility resulting from bony consolidation of the joint, in which, if the muscles are sound, the section should be made through the ramus, in order to obtain the power of the masseter and internal pterygoid.

When the difficulties are such as result from inflammatory lymph about

the temporo-maxillary joint, the resistance must be overcome by insinuating between the teeth a divulsor (Fig. 1628), which will serve to separate the jaws when the handles of the instrument are forced together. The blades of the divulsor must be carefully covered either with rubber or with leather, in order not to injure the teeth.

Wedges of wood are sometimes used to force the jaws asunder, but are inferior in value to the divulsor. When the

FIG. 1628.



Divulsors or lever forceps.

rigidity depends on the presence of lymph between the muscular fasciculi of the masseter, much may be done to favor the absorption of the new formation and restore the action of the muscle by "massage," accompanied with the daily use of the dilator.

Periostitis of the maxilla occurs from both local and constitutional causes. Among the former, caries or some other disease of the teeth, and the vapor of phosphorus, constitute the most prolific sources of the inflammation. The constitutional conditions which excite periostitis are syphilis, mercurial poisoning, rheumatism, certain exanthematous fevers, and struma. The symptoms are pain in the bone, sensitiveness of its surface to pressure, and an elevation of the periosteum, accompanied, in acute cases, with swelling of the face and more or less fever, with general disturbance of the system. When it has a

syphilitic origin, the disease is very insidious, and may make considerable progress before being detected, leaving permanent thickenings or nodes.

The treatment of periostitis of the jaws will depend upon the exciting cause. In acute cases (arising from cold, or from rheumatism), and when there is general soreness of the jaws, and perhaps of the entire body, with dull aching of all the teeth, an active purge, followed by small and frequently-repeated doses of the iodide of potassium and the nitrate of potash in solution, steaming the face with the vapor of hot water, and, occasionally, a dose of Dover's powder, will secure the resolution of the disease. If there are diseased teeth, they should be removed. It is possible that in searching for such no decay may be detected; but if there is a tooth which on being pressed upon, or smartly tapped with the handle of a pocket-knife or a key, is found to be sore, its removal must be insisted upon, though there are no external marks of disease. The connection between the periosteum and the endosteum of the maxilla must not be forgotten, as inflammation of one, if neglected, may terminate by involving the other.

I do not doubt that in some of the cases of maxillary periostitis which have fallen under my notice, and which arose from disease of the teeth, the latter disease was secondary to an inflammatory condition of the alveolar periosteum or the endosteum, or of both together.

Periostitis depending on constitutional conditions, as syphilis or struma, will demand general treatment. When arising from the first-named disease, iodide of potassium, with or without a small amount of bichloride of mercury, will be indicated, provided the constitution has not been seriously damaged by the ravages of the old disease. If this proves to be the case, it will be best to omit mercury in any form, and rely on a judicious alternation of alteratives and tonics, as iodide of potassium, nitro-muriatic acid, and iodide of iron and cod-liver oil.

In strumous periostitis, the use of the last two articles named, with decoctions of sarsaparilla and chimaphila umbellata, together with a diet rich in all the plastic elements of nutrition, and proper hygienic surroundings, will constitute our chief reliance.

Sequels.—Periostitis is liable to terminate in osteitis, abscess, or necrosis.

Osteitis of the maxilla is attended with a gnawing or boring, deep-seated pain in the jaw, with periodical exacerbations of suffering, particularly in the evening or at night, with swelling, also, of the overlying soft parts. The lower jaw is most prone to be attacked. The bone, in consequence of the plastic transudation, becomes expanded or swollen; the teeth generally ache and are tender. The enlargement of the jaw may be limited to a small portion of its structure around one of the alveoli if the disease commenced at the root of a tooth. Or it may be diffused, spreading through the principal part of the bone, and unless speedily checked will end in caries, suppuration, or necrosis.

TREATMENT.—In every case of osteitis the jaw must be carefully examined for any diseased teeth, the removal of which, if found, should take precedence of every other measure. If, after getting rid of this source of irritation, the disease does not spontaneously subside, and if the morbid action is not referable to a constitutional vice, an antiphlogistic course must be adopted.

If the disease ends in caries, there will be one or more fistulous openings, indicated by a little bit of granulation tissue, through which a purulent or watery discharge issues. Under these circumstances, if a probe is introduced into the sinus, the bone will be found honeycombed. When the caries is circumscribed, the molecular ejection of the dead particles of bone may be effected by means of the "liqueur de Villate" or the tincture of iodine; but when extensive, it cannot be left to natural processes, and must be scooped out with a delicate chisel-shaped scraper, at the same time washing out the detritus until the sound bone has been reached.

The known chemical action of certain mineral acids, as the sulphuric, on

the bone-salts, has rendered this agent quite popular as a remedy in caries. When employed for this purpose, the ordinary aromatic sulphuric acid applied daily with a glass brush dissolves away the devitalized osseous fragments and stimulates healthy granulations.

When the expansion of the bone is not promptly arrested, an opening should be made into its structure with the crown of a delicate trephine, on the same principle that incisions are adopted in cases of phlegmonous erysipelas in order to prevent sloughing of the cellular tissue.

Chronic osteitis, depending, as it generally does, on syphilis, will require antisyphilitic remedies.

Abscess.—Suppuration of the jaw may be, as has been stated, one of the sequels of periostitis, yet osteitis and endostitis are intermediate links in the

FIG. 1629.



Circumscribed abscess of the lower jaw.

chain of causation, provoked either by an alveolar abscess or by the presence of diseased teeth, cysts, and other tumors of the jaw. These abscesses are single and multiple, or perhaps it would be more accurate to say circumscribed and diffused. (Fig. 1629.) The latter may so thoroughly disorganize the maxilla as to render all attempts at preservation useless.

SYMPTOMS.—It is no easy matter to diagnose an abscess of the jaw. There will have been a previous inflammatory history, with deep-seated pain, expansion of the walls of the bone, and possibly one or more rigors,—phenomena which indicate the occurrence of suppuration; the same signs, however, accompany other affections of the jaw, as the severer forms of alveolar abscess and endostitis. As the recognition of the true condition is of vital moment in connection with treatment, it will be a wise expedient, in case of doubt, to make an exploratory puncture with a drill or the small crown of a trephine, which, even in the event of no abscess being found, can do no harm. When the suppuration finds its way to the surface of the bone, forming sinuses, as is sometimes the case, the nature

of the disease is self-evident.

TREATMENT.—Abscess, unless it happens to open into the socket of a tooth, can be relieved only by surgical measures; and, as in other tissues, an opening should be made by the trephine or chisel, and the purulent accumulation evacuated, after which the cavity should be washed, and healthy granulations encouraged by treating the interior of the cavity with dilute tincture of iodine. In all these cases of osteitis or abscess, the general health of the patient must be improved by tonics and a liberal diet.

Necrosis.—Though neither jaw is exempt from necrosis, the disease manifests a preference for the lower maxilla. This may possibly be due to the combined agency of great functional activity, the abundance of compact tissue in its structure, and its almost entire dependence on a single artery for its blood-supply,—physiological and anatomical peculiarities which do not characterize the upper jaw, which in mastication is passive, possesses little compact tissue, and receives its blood from several different sources.

The immediate causes of necrosis are periostitis and osteitis. In periostitis, the vital or vascular connection between the membrane and the bone is endangered in consequence of the inflammatory infiltration; and when this connection is destroyed, the death of the bone, to some extent, must follow, either partially or in its totality, affecting the alveolus alone or the bone. It

is true that the life of the maxilla is not wholly dependent on the vessels of the periosteum. The dental branches of the internal maxillary arteries contribute also to the nutrition of the bone, but this is a secondary office as compared with the supply of the teeth; and hence, when the work of substituting the periosteal function devolves upon these vessels, the life of the bone becomes endangered; and when an osteitis is developed, which is often associated with a periostitis, the danger of necrosis is increased in a twofold degree.

The exciting causes of necrosis are traumatism, disease of the teeth, poisons generated in the human body, as in certain exanthemata, scarlatina, variola, and, in one case mentioned by Bryant, in rubeola, also syphilis, the action of mercury, and the fumes of phosphorus.

Alveolar necrosis, when produced by traumatic causes, as the fracturing of the socket in extracting a tooth, requires no active interference. Exfoliation of the sequestrum will, in time, follow without any particular inconvenience being experienced by the patient. When the necrosis occurs at that period of life when the jaw is occupied by the temporary teeth, interference is still less desirable; for, as stated by Mr. Tomes, any premature attempts to drag away the sequestrum may be attended with the loss of the germs of the permanent teeth. It should be allowed to remain until, separated both from the bone and from the tissues of the gum, it can be picked away without force.

Exanthematous necrosis is that form of the disease which attacks the alveolus of the jaw as a sequel of scarlet fever or of some other exanthema. This variety of necrosis was first described by Mr. Salter.* It begins with redness and tenderness of the gums, which soon shrink away from the alveolus lining the necks of the teeth and the bone, leaving the latter exposed. It is accompanied by the peculiar odor which belongs to dead bone about the teeth. The disease generally affects both sides, and sometimes corresponding portions of each. The temporary teeth drop out, and subsequently the germs of the permanent ones, with the sequestrum of the alveolus down to the body of the bone. As the loss of the teeth within the limits of the necrosis is permanent, there necessarily follows deformity varying with the part of the jaw involved, being, of course, less in the regions of the molars than in those more anterior.

The treatment consists in keeping the mouth free from the offensive discharges, and arresting the fetor by frequent washings of weak solutions of persulphate of iron, permanganate of potash, or bromo-chloralum, until the sequestra loosen and can be removed, after which the patient quickly recovers. Tonics, especially iron, with good food, will also be indicated.

Phosphor-necrosis is a comparatively recent form of maxillary necrosis, and owes its existence to a modern manufacturing industry,—the making of lucifer-matches. The first public notice of the disease appeared in Germany, by Lorinser, who had witnessed the necrosis as early as 1839, in an operative employed in a match-factory at Vienna. In Great Britain, the first writer who treated of the disease was Dr. Wilks,† in 1846. Since that time phosphor-necrosis has been noticed by several German writers, particularly by Von Bibra and Geist,‡ whose field of observation was the Nuremberg manufactory of lucifer-matches; and in England, by Salter§ and Bristowe.|| In this country the malady was first described by Dr. James R. Wood,¶ of New York, in 1856. This form of necrosis occurs among operatives engaged in the manufacture of lucifer-matches. Only in a few instances has the disease been contracted in any other way. Mr. Paget** mentions one case

* Guy's Hospital Reports, vol. iv., 3d Series.

† Guy's Hospital Reports, 1846.

‡ Die Krankheiten der Arbeiter in den Phosphor- und Holzfabriken.

§ Holmes's Surgery.

|| Report to Privy Council, London, 1863.

¶ New York Journal of Medicine, May, 1856.

** Medical Journal and Gazette, vol. i. p. 157, February 5, 1862.

in which the necrosis was the result of exposure to the influence of phosphorus in the preparation of certain compounds of which this substance constituted a part.

A child came under my own notice who was suffering from the early symptoms of the disease, in consequence of chewing the contents of a match-box which it had got possession of during the absence of its parents. The little patient passed out of my observation, and of the final result I cannot speak with certainty.

With regard to the manner in which the poison of phosphorus operates there is some difference of opinion. A few writers, among them Lorinser and Langenbeck, believe that the disease is only an expression of general blood-poisoning; but the weight of authority is, with good reason, on the side of its local origin, in confirmation of which no stronger argument can be adduced than the fact that the disease is never seen except in operatives the cavities of whose teeth are exposed by caries. Until this occurs, such persons may labor with impunity, exposed to the deleterious agent. Phosphorus produces its effects, most likely, in the form of either phosphorous or phosphoric acid, its fumes meeting in the air or the mouth the necessary amount of oxygen to form these acids, which, by entering the tooth-cavity, reach the alveolar periosteum, either at the bottom of the socket or on its side.

Both jaws are liable to be attacked, but the lower one suffers oftener than the upper. In an analysis of 111 cases, I find that the necrosis was located in the inferior jaw 58 times, in the superior jaw 41 times, and in both upper and lower maxillæ 12 times.

SYMPTOMS.—The earliest symptom of phosphor-necrosis is a paroxysmal dull pain experienced in some portion of the alveolus occupied by an unsound tooth, and is generally regarded as simply a toothache. The teeth are also sore to pressure. After a time an eruption appears on the gums; they become soft, tender, swollen, spongy, and of a purple or leaden hue. The pain, which at first was intermittent or irregular, becomes more constant. The mucous membrane on the inside of the mouth adjacent to the disease assumes very much the same appearance as that presented by the affected gums; the swelling involves the face, the eyelids, and even the scalp; it extends to that part of the neck below the jaw, greatly altering the general appearance and expression of the countenance. When suppuration com-

FIG. 1630.



Phosphor-necrosed jaw.

mences, the pus escapes around the necks of the teeth, which become loose and drop out; this unhealthy pus, emitting, with the other secretions of the mouth, a fetid odor, burrows along the bone, separating the periosteum, and forming long, fistulous tracks. These open at different points, laying bare

the bone, which generally presents a dull gray or dark appearance and an irregular, worm-eaten surface. (Fig. 1630.) Coincident with these changes, a large fibrinous and corpuscular transudation takes place about the under portion of the bone, assuming the lower jaw to be the diseased one, which plays a most important rôle in the subsequent history of the case. The general system seldom remains undisturbed during the progress of the necrosis. The extensive suppuration and the contaminating discharges which are constantly poured into the mouth, together with the severe pain which is experienced, may induce rigors, followed by an irritative fever, nausea, vomiting, diarrhœa, and profuse sweatings, the patient finally dying from exhaustion or pyæmia.

PATHOLOGY.—The first morbid impression in a case of phosphor-necrosis would appear to be made by the acid upon the periosteal lining of the alveolus. From thence it is most natural to suppose that the inflammation is propagated along two lines of tissue-continuity,—that of the cancellated tissue of the bone and that of the periosteal layer of the jaw,—so that, being attacked on all sides, the body of the jaw must necessarily die in its totality. The disease, in the case of the lower maxilla, is usually limited to the body of the bone, leaving the rami undisturbed; though there are exceptional cases in which the latter have participated in the general destruction, leaving only the condyles, and in a few instances even these have been involved.

REPAIR.—I have already alluded to the accumulation of a large transudation in front and behind the base of the lower jaw, which is actively going on during the progress of the disease. This not only forms an embankment which protects the parts below from the intrusion of pus, after the same manner as does the wall of an abscess, but constitutes, in addition, the mould for reforming the destroyed jaw.

This salutary process may be defeated, but there are a number of cases in which, after the necrosed piece has been extracted, a well-formed rim of bone remained, which had been constructed *pari passu* with the separation of the sequestrum, and which, though unarmed by teeth, continued to discharge the functions of the lower jaw. Such were the cases reported by Billroth, Geist, Perry,* Smith,† Hunt,‡ and Morton;§ and in instances given by Geist, even when the entire jaw with its condyles has been destroyed and ejected, there has followed a like extensive restoration of the bone with very good motion. The durability of the new substitute, however, is not always assured. In some cases at least it has diminished in size under use,—indeed, almost entirely disappeared; and the possibility of such an occurrence gives considerable practical force to the suggestion of Mr. Salter, of providing the supplemental jaw as soon as possible with artificial teeth.

TREATMENT.—The adoption of such measures as will protect the operative against the dangers of phosphorus-poisoning is a duty imperative on every manufacturer of lucifer-matches. It is one of the compensations of industrial life, that, while certain necessary occupations are attended with great personal danger, science has provided the means by which the risk may be greatly diminished or entirely obviated. The collier, with the charm on his head, plies in safety his pick in coal-shafts, surrounded by an explosive gas; and the worker in many of the materials employed in the construction of tapestries and various upholsteries escapes, by the use of carbolic acid, the dangers of carbuncles. A like immunity will be attained if those engaged in carrying on the manufacture of matches will carefully exclude all operatives who are the subjects of dental caries or who neglect to have decayed teeth carefully plugged; they should also provide alkaline respirators to be

* Medico-Chirurgical Transactions, vol. xxi. p. 290, 1838.

† St. Bartholomew's Hospital Reports, vol. i. p. 101, 1865.

‡ American Journal of the Medical Sciences, vol. xlix. p. 353.

§ Surgery, Pennsylvania Hospital, p. 216.

worn by the workmen exposed to the phosphorous fumes. The respirator recommended by Mr. Graham consists of equal parts of unslacked lime and sulphate of soda, quilted in between two layers of some fabric sufficiently porous to admit of the passage of air, which can be worn over the mouth when at work.

In treating a case of phosphor-necrosis, the course of the medical attendant must be regulated by the stage of the disease.

During the early or what may be considered the acute period of the disease, free incisions should be made through the gum down to the bone: by thus opening two or more avenues for the escape of inflammatory products the necrosis may be limited, for it can scarcely be doubted that a part of the destruction of the jaw is the result of purulent burrowing. When this period has passed, the treatment must be an expectant one. In order to defend the system against the poisonous action of the fetid discharges which are poured into the mouth, the latter must be frequently washed out with solutions of permanganate of potash containing a little tincture of myrrh, or with dilute alcohol. The strength of the patient is to be sustained by nutritious liquid nourishment, rest and relief from pain are obtained by the use of anodynes, and any point of bone which may protrude in a way to irritate adjacent parts can be nipped off with a pair of cutting pliers; but no attempts to remove the sequestrum will be proper until it has been thoroughly loosened and detached by natural processes, when it should be seized with a pair of bone forceps and extracted through the mouth. When both halves of the inferior maxilla are involved in the disease, the operation will be facilitated by dividing the bone at its symphysis and removing each half separately, and when the condyles remain unaffected, they must be separated from the rami by means of the cutting pliers. In case the disease is seated in the upper jaw, some modification of the rule as to early surgical procedures may be made, not with reference to the propriety of primary incisions in order to limit the extension of the necrosis, which are as judicious here as when the lower jaw is implicated, but with regard to the extraction of the sequestrum, which may be undertaken at an earlier period than would be proper in the inferior maxilla, on account of the nasal, orbital, or other relations of the bone, as well as of its exceptional disconnection with the muscles.

Syphilitic necrosis.—The bones are peculiarly liable to become affected by the syphilitic poison, and among the different pieces of the skeleton the maxillæ frequently suffer. When the upper jaw is attacked, the palatine plates are usually first affected. Commencing as a periostitis, the disease separates the soft tissues from the horizontal plates by the inflammatory formations, until, deprived of blood, the bones perish; or the destructive process may extend to the alveolus. I have removed the entire palatine plate, and the greater part of the alveolus of both maxillæ, on account of syphilitic disease.

The diagnosis of syphilitic necrosis is easily established. It is among the later manifestations of the disease, and, in addition to the antecedent history, there will always be external signs to attest the syphilitic paternity of the necrosis.

TREATMENT.—If the disease is detected during the early stage of the periostitis, the bone may be saved by active antidotal measures, especially by the bold administration of the iodide of potassium; but after the necrosis has been once established, nothing can be done to get rid of the sequestrum until it has become well detached from the surrounding healthy bone, when its extraction will be indicated.

Mercurial necrosis.—Fortunately, this variety of necrosis is seldom witnessed at present. It is usually accompanied by extensive sloughing of the mucous membrane of the mouth and the tissues of the cheek, occasioning great deformity and disability from the resulting cicatricial tissue. (See *Anchyllosis of the Jaw.*)

The rule for dealing with the sequestrum in phosphor-necrosis applies with equal force to necrosis of the jaw from other causes.

Tumors of the Lower Jaw.

Different kinds of tumors are met with in both the upper and the lower jaw. They may be classified as follows: cystic, osseous, fibrous, cartilaginous, angiomatic, sarcomatous, myxomatous, and carcinomatous.

Cystic Tumors are generally associated with some disease of the teeth, or some error in dentition, and have been already considered under the head of dentigerous cysts.

Occasionally, however, tumors of this nature, both congenital and acquired, have been observed in which the disease could not be traced to the above causes, and which must, therefore, have originated in the endosteum, or in the cancellated tissue of the bone. The characteristic feature of these cysts is a great expansion of the external walls of the jaw, the latter being thinned out to such a degree as to render them pliant and crackling under pressure. The internal appearances of the growths do not materially differ from those presented in well-marked cases of dentigerous cysts, and the same principles will hold in the treatment of both affections.

Fibromata.—A considerable proportion of all the morbid growths of the lower jaw belong to this class. They may arise from the periosteum or from the interior of the bone. Their growth is usually tardy, their prevailing form spherical, their surface smooth, and their consistence firm. When springing from the periosteum, the principal projection of the tumor is external; but when beginning in the central portion of the jaw, it will encroach on the cavity of the mouth, as well as enlarge in the outward direction. Even when growing from the periosteum, the underlying compact wall of bone is often absorbed, so that the growth will form for itself a bed in the cancellated tissue, causing its absorption.

Recurring fibromata are not common in the lower jaw. There is nothing in their outward appearance to distinguish them from a simple fibroma. Internally they have a softer consistence, and contain cell-forms which ally them with the sarcomata. The tendency to recur after removal confers on these formations a certain degree of malignancy which prevents them from being classed as benign neoplasms.

TREATMENT.—Fibrous tumors of the lower maxilla, whether periosteal or osteal, should be removed, along with an ample amount of sound flesh or bone; in some instances they necessitate the excision of the entire half of the jaw.

Sarcomata.—The recurring fibroids and the sarcomata of the jaw are only colossal forms of epulis, the histological elements being very much alike. The growth commences as a small swelling projecting from the gum into the mouth, having a red or livid color, growing steadily, displacing the teeth, filling the mouth, dislocating the lower jaw, and pushing out the face on the affected side. The cheek finally becomes blended with the growth, incorporated with, or rather infiltrated with, its cellular elements, and finally may undergo ulceration, leaving sinuses through which protrude fungous masses of granulations. (Fig. 1631.) In some cases, though the cheek and other soft parts appear to be a part of the tumor, on a closer inspection it will be found that the apparent oneness is only apposition.

These growths are often found mingled with imperfect osseous matter, when they are called osteo-sarcomata; at other times they contain many polynucleated cells, giant cells, or embryonal cells, when they are classed as myelo-sarcomata. Occasionally they undergo a partial cystic transformation, when the term cystic sarcoma is employed to designate the disease. (Fig.

1632.) In all these varieties, however, the fundamental histological element is embryonal tissue in some form.

FIG. 1631.



Sarcoma of the lower jaw.

FIG. 1632.



Cystic sarcoma of the lower jaw.

DIAGNOSIS.—No diagnosis of these growths is reliable which is not based on a microscopical examination of the contents of the tumor.

TREATMENT.—Whatever may be the variety of these tumors, nothing short of an early extirpation of the growth, along with that portion of the bone from which it springs, or, if necessary, the entire bone, will suffice. Even then its recurrence is not improbable.

Enchondroma.—Cartilaginous tumors are not often met with in the lower jaw. They may be recognized by their irregularity or lobulated appearance, and by their density, occupying a place in this respect between fibromata and osteomata. Any part of the jaw may become the seat of these growths, though generally that part between the lateral incisor and the last molar is selected by the disease. It has both a periosteal and an osteal origin, acquires great bulk, and sometimes involves the entire half of the jaw.

When of small size, enchondromatous tumors are made up of a number of cartilaginous masses bound together by intermediate bands of connective tissue, and are remarkable for the diversified forms of cartilage which enter into their composition.

TREATMENT.—When small and occupying the surface of the bone, it will be sufficient to cut away the growth by a chisel or a Hey's saw. When much of the bone is included in the mass, nothing short of the removal of the former will suffice. When the operation has been thorough, no return of the disease need be anticipated. Maxillary enchondromata, when allowed to remain, cause death by pressure, interfering with respiration and deglutition by encroaching upon the larynx and œsophagus.

Osteomata.—An enchondroma undergoes, in some instances, ossification, producing in this manner an osseous tumor. The structure of such a formation, when exposed, exhibits a porous or spongy appearance, it retains its lobulated shape, and if its previous history is carefully elicited it will be found that the transformation was characterized by a progressive solidification, which was detectable by the pressure of the finger. There are bony tumors which have a peripheral and others which have a central origin; that is, spring from the external surface of the periosteum of the jaw, or from the tissue between the compact walls of the latter. Those which grow

from the periosteum, or outer plate of bone, answer to what are usually termed exostoses; those which arise within the compact walls of the maxilla may be styled intra-osseous tumors.

The osteomata of the jaw have all degrees of density, from a spongy texture to an ivory hardness (eburnated or ivory osteoma).

A differential test has been given by histologists to distinguish those osseous growths which are exostoses from those which develop in the more central portions of bone, namely, the perpendicular disposition in the former growths of the Haversian or vascular canals in continuity with those at the surface of the bone where the tumor is attached.

TREATMENT.—Eburnated tumors having a superficial connection with the jaw can be successfully removed by the chisel or saw, but when involving the body of the bone the only effectual mode of disposing of them is to remove the corresponding portion of the maxilla.

Carcinoma of the lower jaw is frequently encountered. The form most common is encephaloid or medullary cancer. Rarely do we meet with scirrhus, melano-carcinoma, or melano-sarcoma. The great frequency of carcinoma as compared with other tumors of the jaw will appear from an analysis made by Otto Weber of 403 morbid growths of the inferior maxilla, of which number 162 were cancer.

Carcinoma, beginning in the central part of the bone, generally grows with great rapidity, separating the external laminae of the jaw, which soon give way, allowing the soft fungous mass to protrude into the mouth, and uniting to itself the adjacent soft tissues of the gum and the cheek in one indistinguishable mass. On the surface of this, through ulcerated openings, grow several fungoid masses of soft, bleeding granulations (Fig. 1633), accompanied with infection and enlargement of the lymph glands under the jaw and in the neck.

In the diagnosis of encephaloid cancer of the jaw there are three signs which are entitled to much weight: these are *rapidity of growth*, the *implication of the surrounding soft tissues by the tumor*, and the *enlargement of the nearest lymphatic glands*.

FIG. 1633.



Encephaloid cancer of the lower jaw.

Affections of the Antrum and Upper Jaw.

Inflammation of the lining membrane of the antrum, except as an extension from the mucous membrane of the nasal fossa, with which it is continuous, or from diseased or displaced teeth, or the presence of a foreign body, must be exceedingly rare. I can recall no case of the kind. As a secondary condition, however, inflammatory troubles arise which terminate in abscess or dropsy.

Abscess.—The roots of the first two molar teeth form a prominence in the floor of the maxillary sinus. An extremely thin layer of bone separates the two. It follows, therefore, that inflammation may be readily propagated to the lining membrane of the cavity if these roots are diseased. Not unfrequently teeth find their way—particularly in cysts of the jaw—into the antrum, and, acting as foreign bodies, cause suppuration. Pus is sometimes found in the sinus independent of any inflammatory changes in its lining, as where an alveolar abscess breaks through its floor.

Abscess may also arise from traumatic causes, as blows upon the face, or gunshot wounds.

SYMPTOMS.—The early symptoms of abscess of the antrum are a deep-seated pain in the region of the sinus, occasionally radiating in different directions upward, outward, and downward in the lines of the branches of the second division of the fifth pair of nerves, and tenderness and swelling of the cheek. These symptoms, so often present in other affections of the upper jaw, would not justify the conclusion that an abscess existed. After a time, however, others of a more decisive character appear.

The swelling of the face continues to increase, with more or less œdema, but without any increase of tenderness. A sense of fullness is experienced in the jaw, as though something was exerting a centrifugal pressure. A chill, followed by some febrile disturbance, occurs, and finally pus begins to discharge from the anterior nares of the affected side, and, on exposing the cavity of the nose, may be seen to enter the latter from the side of the middle meatus. If from any cause the opening into the nasal fossa becomes obstructed, and the purulent collection continues to accumulate, the walls of the antrum will yield, either upward, pushing before it the floor of the orbit, in which case there will be some displacement of the eye and an increase of swelling at the upper portion of the cheek, or anteriorly, causing a marked projection of the cheek, with possibly a parchment-like crepitation of the facial wall of the sinus when subjected to pressure.

In a case of abscess of the antrum under the care of Mr. Salter, in which the floor of the orbit was opened by the disease, the pus discharged on either side of the eye, causing the loss of the ball.

TREATMENT.—A careful inspection of the teeth should be the first step in the treatment of an abscess of the kind under consideration. If any are found decayed or otherwise diseased, they should be promptly extracted, whether any defect is discovered in the teeth or not. The contents of the antrum must be evacuated, and this requires that an opening shall be made into its cavity. This can be effected by passing a drill through the anterior wall of the sinus where it joins the wall of the cavity, and will require the instrument to be entered on the inside of the mouth in front, where the mucous membrane is reflected from the cheek to the alveolus. If one of the molar teeth, preferably the second, is absent (and if not, then one may be extracted for the purpose), the perforation can be made still more satisfactorily by passing a drill, or a trocar and canula, or the trephine of Pope, through the bottom of its socket into the cavity of the sinus.

An opening made in this situation is admirably adapted for drainage, though more likely to admit particles of food and other substances into the antrum. After emptying the abscess, the cavity should be daily washed out with solutions of permanganate of potash, sulphate of zinc, or dilute tincture of iodine. Any one of these can be thrown into the sinus by means of a syringe having a nozzle suited to the size of the aperture, taking care afterwards to plug the opening with a little piece of wax, or a roll of wool secured to a thread, so as to prevent the intrusion of foreign matters into the sinus.

Antracèle, or dropsy of the antrum, consists in an accumulation of fluid in the maxillary sinus, giving rise to a painless expansion of its walls, and forming a considerable swelling over the corresponding portion of the face in well-marked cases of the disease. Nor does the anterior wall of the antrum alone yield, causing the facial enlargement, but the orbital, nasal, and palatine portions of the bone also give way, producing displacement of the eye, obstruction of the nasal passages, and bulging of the hard palate. It is quite common to find the facial wall of the sinus thinned out by absorption until it becomes flexible, and crackles, when pressed upon, like parchment. Often, indeed, the bone is entirely destroyed, leaving only the thickened periosteum and soft parts of the face in front of the swelling.

PATHOLOGY.—The earlier views entertained with regard to the disease attributed it to mechanical causes. The dropsy was believed to be due to

the opening between the middle meatus of the nose and the sinus becoming closed, in consequence of which the secretion of the cavity, not being allowed to escape, accumulated so as to form the enlargement. By Adams, Giraldès, and Luschka, who have made this affection a subject of special investigation, the disease is regarded as a cystic degeneration of the glands of the mucous lining. While this is doubtless correct in many instances, it will not hold good in all. These accumulations in the antrum have a wider causation.

There is a remarkable difference in the appearance of the fluid found in the sinus. It sometimes resembles in its physical and chemical characteristics that of a hydrocele or an ascites, thin, straw-colored, and coagulable by heat. Sometimes it is thick and glairy, having the consistence of a syrup; at other times it is purulent, may have a yellowish-white color, and resembles the soft or semi-fluid contents of a sebaceous cyst. Crystals of cholesterol are also found in the liquid contents of these enlargements. Some of these appearances are doubtless the result of degenerated changes in the liquid formations, rendering the latter very unlike what they were originally. Conditions so diverse are not always the products of cystic disease; frequently they arise from chronic inflammation and states of the lining membrane of the antrum provoked by various irritants propagated from the nasal mucous membrane, or connected with the roots of the teeth and with errors of dentition. Several instances of the disease have been witnessed in which a tooth had entered the sinus and produced the inflammatory accumulation. In other cases an abscess of the alveolus or a dentigerous cyst has opened into the antrum and given rise to the affection.

The diagnosis of antracoele is not attended with any difficulty after the walls of the sinus have become much attenuated or have been absorbed, as, under these circumstances, it is not difficult to recognize the presence of fluid contents. If any uncertainty should exist, however, it will be well to introduce an exploring needle to remove the obscurity. Unless such favoring circumstances exist, it is possible to confound the dropsy with growths of a more solid nature. I have seen a surgeon lay open the cheek preparatory to removing the superior maxilla for what was supposed to be a fibrous tumor, when, after uncovering the bone, the anterior wall of the antrum gave way, discharging a large quantity of straw-colored serum, the presence of which constituted the tumor.

TREATMENT.—The treatment of antracoele is not, usually, attended with any difficulty. A free opening should be made into the sinus, between the cheek and the gum, with a knife, or, if the bone is too thick to be divided in this manner, then with a drill, always enlarging the orifice by nipping away the bone around the opening with pliers until the little finger can be insinuated into the sinus. A digital exploration should never be neglected, otherwise it is impossible to determine with certainty whether the disease arises from cystic inflammatory causes, or from the presence of a tooth.

After emptying the contents of the antrum and removing any foreign body which may be discovered, or breaking up any cysts, its cavity should be injected every second or third day with a solution of sulphate of zinc, five grains to the ounce of water, or a solution of sulphate of copper of the same strength, or tincture of iodine half the officinal strength.

Fistulous Opening.—After an operation on the maxillary sinus, or in consequence of a diseased tooth, a fistulous opening may remain, through which a little pus or muco-pus issues. Many persons allow an orifice of this kind to remain for years, plugging it up in the intervals of cleansing with a little stopper of pine wood, in order to obviate the annoyance of the frequent discharge of matter into the mouth.

When a fistula persists in this manner, either the cause of the original disease has not been removed, or there is some defect in the drainage. The remedy lies in making a free and direct opening into the cavity, and, after re-

peating the exploration, injecting tincture of iodine of full strength. When the fistula opens through the alveolus, any diseased tooth-roots which may be present must be extracted preliminary to injecting.

Tumors of the Antrum.

There are two forms of morbid growths found in the antrum: one consisting of hypertrophied glands, or glands undergoing cystic degeneration, as described by Giraudeau, and the other histologically allied to tubular epithelioma. The last is a recurring, and doubtless a malignant, neoplasm.

Commencing in the antrum, these tumors, especially the latter variety, after expanding the walls of the cavity in all directions, and giving rise to singular distortions and deformities of the face, grow into the nose, obstructing the nasal cavities, and are often confounded with nasal polypi. They may occasion, also, absorption of the osseous walls of the sinus, and protrude into the mouth, the pharynx, or the base of the skull.

TREATMENT.—They require for their extraction the removal of the anterior walls of the antrum. When feasible, this should be done through the mouth, without opening the face, by dissecting the soft parts from the jaw and cutting the latter away.

Tumors of the Upper Jaw.

The tumors which develop in the upper jaw are of the same nature as the morbid growths of the lower maxilla, though their effects are more serious and they cause greater deformity.

The most common varieties of tumors affecting the upper jaw are sarcoma, carcinoma, and osteoma. Enchondroma, fibroma, and cystoma are comparatively rare.

Sarcoma, answering to the fibro-plastic tumor of Lebert, commences either on the external surface or the interior of the upper jaw, in the same manner as does the so-called epulis, and generally grows with rapidity, causing destruction of the osseous tissue, from which, or in the midst of which, it develops. When the tumor has its origin within the substance of the bone, it constitutes *myelo-sarcoma*.

Sarcoma of the jaw appears as a dense, oval, oblong, or irregular enlargement, the form being determined by the resistance of the superincumbent tissues, and by the superficial or central origin of the disease.

It is not, at first, accompanied by any pain. As it grows, the overlying parts become stretched, forming a tumor either on the inside of the mouth, covered by the tissues of the gum or the mucous membrane, or on the jaw, over the canine fossa; or the tumor occurs on the face if the disease is seated higher up on the jaw, producing a prominence of the cheek or of the side of the nose.

The disease, in its progress, often causes, when central, expansion and parchment-like thinning of the bone, or, if developing inward, produces destruction of the walls of the antrum, entering that cavity, and from thence spreading in all directions, displacing the eye, and extending into the nasal fossæ, mouth, and pharynx, sphenoid cells, pterygo-maxillary and temporal fossæ,—indeed, into every inequality between the bones of the face and those of the skull,—and causing the most repulsive and unnatural deformities. (Fig. 1634.) It is singular to what extent the soft parts of the face are often stretched by a sarcomatous tumor without becoming incorporated with the growth or undergoing ulceration. Only in rare cases does this follow.

The histological elements of maxillary sarcomata differ somewhat according to the original seat of the tumor. When originating from the periphery of the bone, the formed elements are chiefly round and spindle-shaped cells; and when developing centrally or in the interior structure of the jaw, the

myeloid, or embryonal, and multinuclear giant-cells prevail. The interior of these tumors is often filled with cysts. The first variety of sarcoma occurs in early adult life; in the latter the subjects are more advanced, about or after the age of forty.

When ossification takes place in a sarcoma, though, as in smaller growths elsewhere, it is usually incomplete, no perfect bone being formed, yet the tumor is often termed an osteo-sarcoma.

DIAGNOSIS of sarcoma of the upper jaw is a matter of presumption rather than of certainty. When a growth of the maxilla makes its appearance before mature life and increases rapidly; when its surface is irregular, crepitates on pressure, and presents here and there a soft, probably a fluctuating, spot, especially if there is no tendency to ulceration of the soft tissues of the cheek, there are reasonable grounds for regarding the tumor as a sarcoma.

TREATMENT.—Nothing short of excision of the entire bone involved in the disease will avail; and even then its recurrence need not cause any surprise.

Carcinoma.—Carcinoma is much more common in the upper than in the lower jaw, and is almost invariably of the encephaloid character. No period of life is exempt from the disease, nor is it a respecter of sex, male and female suffering with like frequency. It has no fixed point of origin, commencing in the body of the bone, on the walls of the antrum or within its cavity, or in any portion of the jaw or its periosteum.

Carcinoma may exist some time before it is recognized, being concealed in the antrum or in the zygomatic recess of the skull. In these locations it gives rise to obscure and unintelligible pains before making any external show.

The common history of a case of carcinoma begins with the appearance of a small, hard tumor,—at first painless, afterwards painful,—occupying some portion of the upper jaw, projecting downward between the cheek and the jaw, or outward, upon the side of the face. When the disease begins in the antrum or over its external wall, or even in the cancellated tissue at the base of the alveolus, it develops in different directions, generally first in that in which the least resistance is encountered. Thus, it may grow into the nasal cavities, or, pushing off the orbital plate of the superior maxillary, encroach upon the orbit and cause displacement or even destruction of the ball of the eye. Or the horizontal plate of the same bone may be expanded, and the tumor, covered by the tissues of the hard palate, project on the roof of the mouth. Sometimes the direction of the alveolar border of the jaw is changed, assuming a somewhat horizontal position, with the teeth directed outward. As the growth advances, the cheek, lips, and ala of the nose become swollen and œdematous (Fig. 1635); the compact lamella of the bone, gradually undergoing absorption, finally gives way; a fungous, bleeding growth projects into the mouth or the nose, extending at length into the various sinuosities at the base of the skull; the breathing becomes noisy, and deglutition difficult; the saliva dribbles from the mouth, while the articulation is wholly guttural. As the pressure at the base of the cranium increases, the patient suffers from drowsiness and stupor, dropping into a snoring sleep even in the midst of conversation. The discharges from the proliferating masses of fungoid granulations, consisting of blood and ichorous pus having an offensive odor, aid in poisoning the general system, the implication of which becomes visible in the en-

FIG. 1634.



Sarcoma of the jaw.—From the museum of the University of Pennsylvania.

largement of the lymph glands of the neck, in the dirty hue of the skin, and in the emaciation and loss of strength which precede the fatal termination of the disease.

Carcinoma commencing in the antrum or in the cancelli of the bone does

FIG. 1635.



Carcinoma of the upper jaw.

not run its course with the same rapidity as when it begins on the surface of the jaw. The resistance of the osseous walls in which it is imprisoned serves to restrain its growth and prolong life. I have twice seen patients under these circumstances live for twelve years, until, indeed, from the magnitude of the growth, the face had lost all traces of humanity and was transformed in appearance into that of a beast.

The signs which indicate a tumor of the jaw to be carcinomatous are the presence of lancinating pains, the rapid implication of the skin, the tendency to ulcerate and to push out fungous, bleeding, and fetid granulations, with contamination of the lymphatic glands and the early appearance of a cachexia. Rapidity of growth, of itself, is not an important diagnostic sign, as there are other tumors of the jaw, particularly

sarcoma, which increase as rapidly as carcinoma. In all cases the exploratory use of the needle is desirable, obtaining thereby some of the contents of the tumor with a view to subject them to a microscopic examination.

The minute structure of these growths does not differ from that of medullary cancer in other parts of the body, being made up of alveolar arrangements of connective tissue, the cavities being occupied by variously-formed cells and richly supplied with blood-vessels.

Incisions should not be made into these neoplasms, as they merely open a way for the protrusion of a mass of bleeding and fetid fungus.

TREATMENT.—As maxillary carcinoma is rarely found associated with cancer in other parts of the body, there is in its apparently local origin a great temptation to early operations,—a course which has never received my sanction. In advising or practicing operations for this disease I have always been governed by the following rules. When the disease is making slow progress and manifests no tendency to contaminate the soft parts, abstain from using the knife. When the growth, on the contrary, shows a disposition to run an acute course, or is situated in the antrum, and the walls have given way at one or more points, then let the maxillary bone be removed in its entirety. When the tumor has existed for some time, and there is every evidence that the growth has extended beyond the limits of the jaw into the deeper recesses behind the bone or into the nasal fossæ; when the soft tissues of the face have become diseased and adherent to the morbid mass; or when the lymph glands have become tender and enlarged, operation is useless, and, in my judgment, only tends to shorten life. Under any circumstances the disease will return.

Fibroma.—Fibrous tumors of the upper jaw are quite uncommon, although frequently met with in the lower maxilla. Like other neoplasms of the jaws, they may have either a peripheral or a central origin, or may begin in the antrum or upon the palatine plate of the maxilla. When recognized in the antrum, or as growing from some central point of the jaw, there is some uncertainty as to their true origin, since they possess a tendency to develop

through the small fissures connecting with the cavities of the maxilla, the latter becoming only secondarily involved.

This disposition to wander is, however, by no means an early characteristic of the tumor when its original seat is in the jaw. On the contrary, while it may attain a large bulk, it manifests little disposition to extend beyond the bone where it has fixed its seat. The tumor grows slowly, is dense, but not painful, has a lobulated form, and exhibits no tendency to ulcerate or to contaminate the system. When growing from the surface of the jaw, the base is usually broad, and does not penetrate into the bone; when seated in the antrum or cancellated structure, the walls of the bone are expanded and thinned as the growth increases in size. The prominent surfaces of the tumor are generally those towards the face and alveolar border and hard palate, though in that case the growth will trench on the orbit and the nose. When the mass has attained considerable size, patients will often complain of neuralgic pains in the face, temple, and ear.

These tumors are made up of dense masses of white, shining, fibrous tissue, having few blood-vessels, the different lobules being united together and the exterior of the tumor covered or inclosed with the same material, though compact in the arrangement of its fibres.

They are often interpenetrated with splinters or small nodules of calcareous matter.

The diagnosis of fibroid tumors of the upper jaw is based on their slowness of growth, their hard, irregular, nodulated surface, the continued absence of pain, the healthy state of the adjacent structures, and the absence of any tendency to invade the underlying bone, to undergo ulceration, or to cause glandular enlargement or constitutional contamination.

TREATMENT.—These tumors, when of limited size, can often be enucleated by cutting down on their surfaces; and, if possible, this should be done without opening the cheek or detaching the soft parts, an operation which, in consequence of their sinking into all the irregularities of the tumor, is often quite tedious and difficult. The cutting out is done with a saw and chisel. When springing from the periosteum, they can be detached from the bone by cutting through the dense fibrous tissue with which they are surrounded and prying the mass off without disturbing the jaw at all. Enucleation is often practicable when the tumor occupies the antrum, requiring only that its surface shall be thoroughly uncovered in order to give free access to the cavity.

If we could always be certain that the growth was simply a fibroma, such a course would be preferable. This not being the case, it is better, especially if the growth has implicated much of the jaw, to remove the latter in its entirety, leaving, if possible, the orbital plate. I am not in favor of gouging operations for the removal of morbid growths of the jaws, unless they are very circumscribed and entirely benign in their nature. It is greatly preferable to make clean sections of the bones, even if a little more of the jaw is taken away than might possibly have been required, the error being usually in the other direction.

If the tumor is purely fibrous, no return may be anticipated; but should it contain any myeloid or sarcomatous cell forms, its return will not be improbable.

Enchondroma.—Cartilaginous tumors have rarely been seen on the jaws. Heyfelder has found in 450 cases of diseases of the jaws 8 cases of enchondroma. A few cases have been recorded by Morgan,* Beaumont,† O'Shaughnessy,‡ Heath,§ Beck, and others.

The favorite seat of enchondroma of the jaw is on the anterior face of the bone, or somewhat near the nose (Fig. 1636), commencing in the deeper layer of the periosteum. These tumors are prone to undergo osseous transforma-

* Guy's Hospital Reports, vol. i.

† Royal Medical and Chirurgical Society's Transactions, vol. xxxiii. p. 243; Holmes.

‡ O'Shaughnessy on the Bones.

§ Heath on Injuries and Diseases of the Jaws, p. 244.

tions. Of this nature were those recorded by Beck, Hancock, and Collis.

FIG. 1636.



Enchondroma of the upper jaw.—From a cast in the museum of the University, Smith's collection.

portion of the bone on which the growth rests, for without such precaution its reproduction is probable. In a case recorded by Heath, the tumor had been previously excised on three occasions, once by Mr. Le Gros Clark, once by Mr. Partridge, and once by Professor Gunn, of Ann Arbor, Michigan, to which place the patient had come from England. The disease again appearing, the patient returned to England, where he was operated on a fourth time, by Mr. Heath, but died, not from the operation, but some time following, from an attack of erysipelas.

Osseous Tumors.—Bony tumors of the jaw occur in two forms, growing either from a circumscribed surface of the maxilla or from its cancelli.

The first may be regarded as an exostosis. On several occasions I have seen such tumors on the hard palate, which became quite troublesome and sore on account of the friction to which they were subjected in masticating the food. In two of the cases, though under my observation for several years, I have not been able to notice any marked increase.

FIG. 1637.



Bony tumor of the upper jaw.

An osteoma occupying the facial surface of the upper jaw will produce much deformity. (Fig. 1637.)

A very remarkable instance of a large bony tumor which underwent spontaneous separation from the jaws is recorded by Mr. Heath. Its detachment appears to have been brought about by caries of the bone around its base. When the osseous formation is more general, the disease would be more clearly expressed by the term hypertrophy.

The entire maxilla or any part of the bone may become the seat of such enlargement. It is seen in the tuberosity, and may extend to the alveolar process of the jaw. (Fig. 1638.) In one case, that of M. Michon, an osseous tumor grew from the lower surface of the orbital plate of the frontal bone, filling the antrum. In another case, that of Dr. Duka, also recorded by Heath, the tumor had become detached from its bony origin, and lay loose in the antrum.

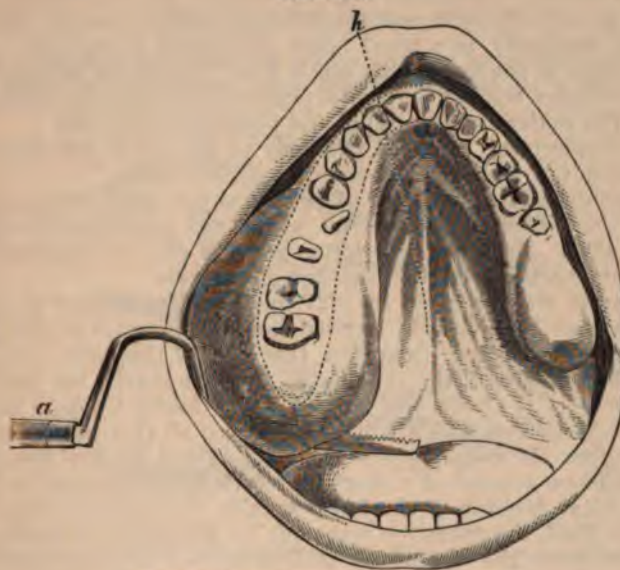
They may grow to a large size. The most remarkable example of this kind is the one given by O'Shaughnessy, which in a single year attained the weight of four pounds.

The diagnosis of enchondroma must necessarily be uncertain, the best indication being the density of the tumor, which is between that of an osseous and that of a fibroid growth; but this is entirely too fallacious a sign to merit much consideration. An enchondroma does not materially differ in appearance or external characteristics from other tumors of the jaws, —a fact which aids in rendering the diagnosis a matter of some uncertainty, particularly in the early stages.

TREATMENT.—Early removal should be practiced, including a

The structure of osteomata of the jaw is either hard, dense, or ivory-like, or soft and spongy. Those which partake of the character of exostosis are generally more compact than those which commence centrally. They seldom

FIG. 1638.



Hypertrophy of the tuberosity of the upper jaw.

appear before middle life. Bony tumors are usually slow of growth, are extremely hard and irregular on their surfaces, devoid of pain, show no tendency to ulcerate, and become serious only when, from their bulk or location, they are obstructive to the nose, mouth, orbit, or the movements of the jaws.

The causes which are influential in producing tumors of the upper jaw are the same as those which give rise to similar diseases in the lower maxilla, namely, disorders of the teeth, and sometimes blows upon the face, clearly indicating an inflammatory origin.

TREATMENT.—When small, causing no inconvenience, and showing no tendency to grow, no surgical interference is necessary; but when the reverse is the case, they should be excised. When limited to a portion of the jaw, or when occupying the antrum, the removal can be effected by the aid of chisel, gouge, bone forceps, and pliers, and a small saw, but much more satisfactorily by the disarticulation of the maxilla. When the disease assumes the form of a diffused hypertrophy, it will be necessary to extirpate the entire jaw, always leaving in this, as in every operation of the kind, the orbital plate of the bone, if possible.

There is a general hyperostosis of all the bones of the face, which produces a singular change or deformity of the face,—the osseous leontiasis of Virchow. Cases of the kind have been reported by Howship, Gruber, Bickersteth, and Sir Astley Cooper. Heath mentions one in which the hypertrophy was unilateral. This disease is possibly the result of inflammatory causes, and, when general, admits of no remedy.

Excision of the Jaws.

HISTORY.—The removal of the whole or portions of the maxilla in cases of morbid growths affecting the jaws has become a recognized and well-established surgical procedure. To Deadrick,* of Tennessee, in February,

* Medical Recorder, vol. vi., 1826.

1810, the profession became indebted for the first partial resection of the lower maxilla. The patient was a boy who had an enchondroma attached to the left side of the lower jaw. The growth had increased to such a degree as to interfere with deglutition, and demanded surgical interference. The tumor was exposed by two incisions through the cheeks, the one running obliquely from the zygoma to the chin, and the other extending from the middle of the first incision, vertically, to a point below the middle of the jaw. The bone was cut through at the symphysis and a little in advance of the angle, thus removing the entire body or horizontal portion of the maxilla, with the tumor attached. The patient made a rapid and permanent recovery.

In 1812, Dupuytren* removed the body of the lower jaw from angle to angle on account of a cancerous tumor.

There is an excision of one-half of the lower jaw attributed to Mr. White, surgeon to the Westminster Hospital, which was performed in Cambridge, England, in 1812. From the description given of the case by South, it would appear to have been removed on account of necrosis.

The operation was repeated in 1821 by Valentine Mott,† of New York. In the same year Von Graefet excised the anterior part of the jaw in the case of a cancerous disease occupying this part of the bone. A small portion from the surface of the maxilla at the symphysis, not including the entire thickness of the bone, was excised by Sir Astley Cooper§ in 1818. In 1823, George McClellan, of Philadelphia, excised all that part of the jaw between its angles. It would appear that in England the first removal of the inferior maxilla on account of a morbid growth was performed by Wardrop.||

The first total excision of the lower maxilla was made by Signorini, and soon after, in 1843, the operation was done by Heyfelder, of Erlangen. Following these came the operations of Professors Carnochan and Wood, of New York, and, in 1850, that of Professor Ackley, of Cleveland, Ohio.

The first partial excision of the upper jaw is ascribed to Acoluthus, a surgeon of Breslau, in 1693. With the exception of the very slight operation executed by Jourdan on the antrum, in 1768, and the more extensive one of Dupuytren on the alveolar process, in 1819, the next extensive resection of the upper jaw, in which all the bone was removed except the orbital plate, was performed in this country by Dr. Jamison, in 1820.

A still more daring excision was practiced four years later, in September, 1824, by Dr. D. L. Rogers,¶ of New York, who removed both upper maxillæ, leaving only the tuberosity of each.

A similar operation was done the following year by Dr. Alexander Stevens, also of New York,** in which not only the entire maxillary was removed, but along with it the malar and partially also the sphenoid and ethmoid bones. This case was not made public, owing to personal objections on the part of the patient, until 1840.

The credit, however, of first removing the entire superior maxilla along with the malar bone was generally at the time conceded to Gensoule, Hôtel-Dieu, Lyons, France, his case having been published. This operation was done in 1827, though it had been proposed by Lizars one year previously,—in 1826. Lizars, in his first attempt to remove the upper jaw in a case of carcinoma, was obliged to abandon the operation on account of hemorrhage; but in 1829, and again in 1830,†† he was more successful, having excised the superior maxilla twice. In 1842 the upper jaw was again excised, by Mussey, of Cincinnati, and by Warren, of Boston. In 1844 the first complete excision of both upper maxillæ was executed by Heyfelder, and in 1848 Dieffenbach

* *Lancet*, vol. i. p. 56, 1831.

† *Gibson's Surgery*, vol. ii., 1827.

‡ *Jahresbericht des Chirurgisch-Augenärztlichen Institutes an Berlin*, Graefe und Von Walther, *Journal*, vol. iii. p. 256, 1822; *Chelius*.

§ *Cooper and Travers's Surgical Essays*, Part I. p. 179, 1818; *Chelius*.

|| *Lancet*, vol. ii. p. 27, 1826-27.

¶ *New York Med. and Phys. Journal*, September, 1824.

** *New York Journal of Medicine*, New Series, vol. vi., 1831, p. 308.

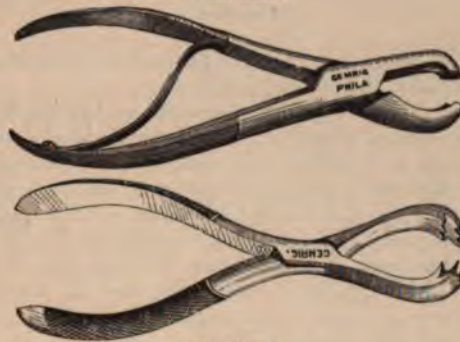
†† *Lancet*, vol. ii., 1829-30.

removed, in addition to the major part of both these bones, the malar and the palatine pieces. These pioneers having thus opened the way in this department of bone surgery, their example has been followed by almost every surgeon of any experience.

Resection of the Lower Jaw.

When it is desired to remove a portion of the alveolus, there will be required a scalpel, one or more tooth forceps (Fig. 1639), a metacarpal saw

FIG. 1639.



Lion forceps.

(Fig. 1640), and two strong bone pliers (Fig. 1641), with retractors (Fig. 1642), and a chain saw.

In all operations upon the maxillæ, upper or lower, full anæsthesia should be kept up only during the extraction of the teeth and the incision and dis-

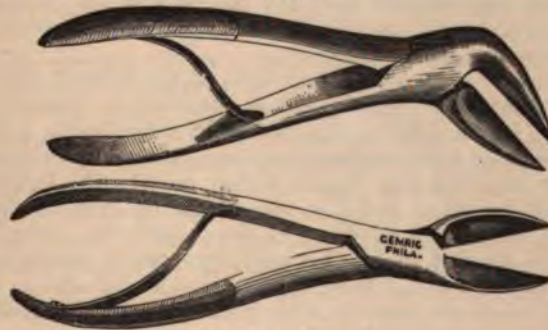
FIG. 1640.



Metacarpal saw.

section of the soft parts of the cheek. When the process of disarticulation commences, it is better that the patient be not too profoundly affected, as the blood may pass into the larynx. Frequent cleaning out of the pharynx

FIG. 1641.



Cutting bone pliers.

with sponge mops, properly secured in the grasp of a sponge-holder or to long pieces of wood, must be diligently kept up.

Operation for partial excision.—The patient being seated on a chair, an as-

sistant stands behind and supports the head against his breast, while with a hand at either angle of the mouth he everts and depresses the lip, holding it

FIG. 1642.



out of the way of the operator. Or the patient may lie on a reclining chair, which is still better than the sitting posture.

Supposing the disease to be a fibro-sarcoma occupying half an inch of the alveolus, the soft tissues of the gum should be divided down to the bone on all sides of the tumor, and sufficiently distant to be outside of the limits of the disease. With the metacarpal saw two vertical cuts of the alveolus are next made, answering to the lateral incisions of the gums, extracting, if necessary for the purpose, any teeth which may be in the way of the saw. As soon as the jaw has been divided down through the alveolus to its body, the bone pliers should be applied horizontally, and the diseased piece cut out. The vertical cuts are sometimes made with the angular-bladed pliers instead of with the saw; but the lines of division are prone to deviate from the proper course, or splintering of the bone may occur.

Excision of the middle of the bone.—The most convenient method of removing the middle of the jaw is the following. Transfix the middle of the lower lip with a sharp-pointed bistoury, at its junction with the chin, cutting directly upward to its free border; next prolong the incision downward to the lower edge of the chin, and then horizontally for a short distance on each side along the base of the jaw. Dissecting the flaps from the bone, a perfect exposure of the middle of the maxilla is made for some distance on each side of the symphysis. A stout needle, having attached to it by a ligature one end of a chain-saw, is now to be passed from below upwards on the inner side of the jaw.

As soon as the point of the needle appears on the surface, it is to be seized and drawn through, followed by the chain-saw. The needle being detached, the handle of the saw is to be attached, and the bone sawed through from within outward, previously removing any teeth which may interfere with the section. The bone is to be treated in a similar manner on the other side, when, being thus disconnected with the lateral portions, it can be dissected away from its attachments to the mucous membrane and the genio-hyoid, genio-hyo-glossi and digastric muscles.

As all the anterior muscular connections of the tongue are severed, care must be taken, before the detachment is complete, to prevent the possible retraction of the organ against the glottis, by introducing a silk thread or silver wire through its under surface where it is entered by the genio-hyo-glossi muscles. After securing any vessels which require the ligature, the flaps are to be brought together, and the sides of the lip attached by the twisted suture, and the remaining portions of the wound by interrupted sutures. The jaw may be divided in another way, by sawing partially through the bone with a small saw, and cutting the remainder with strong bone pliers.

I have also divided the maxilla with great rapidity by means of a small circular saw driven by a dental engine.

Excision of one lateral half of the inferior maxillary.—A growth may involve so large a portion of the jaw as to require the removal of the entire bone on one side.

The first step in the operation is to uncover the tumor and at the same

time expose the jaw. With these objects in view, two incisions have been devised. That of Lizars, of Canada, consists in dividing the cheek from a short distance in front of the ear to the commissure of the mouth and reflecting the inferior flaps. The other, which, in my judgment, is much to be preferred, is made as follows: selecting a point three-quarters of an inch in front of the ear, and on a line extending from its lobe to the anterior naris, carry an incision directly down upon the masseter muscle, over the ramus, to the angle of the jaw, from thence along the base of the latter to the symphysis menti, and then directly upward over the chin and through the lower lip, stopping a little short of its red border, which need not be severed.

The object of locating this first cut, as I have directed, over the ramus, is to avoid the parotid gland where it overlaps the masseter muscle, and also the parotid duct. The facial artery will be divided in the horizontal portion of the cut, and must then be tied. By passing a pin beneath the vessel where it reaches the jaw, and making a few figure-of-eight turns with a thread preliminary to making the incision, bleeding from this source may be prevented. The soft parts covering the horizontal parts of the jaw are now to be dissected up, exposing this portion of the bone or the tumor which corresponds to it, from the ramus to the symphysis. This done, the insertion of the masseter muscle is next to be separated from the ramus or the growth, either with a knife or, preferably, with an instrument resembling a periosteal elevator. (Fig. 1643.) The next step consists in dividing the maxilla

FIG. 1643.



Dissecting elevator.

at the symphysis with a saw, after which it is to be grasped with the fingers and drawn outward. The soft parts at the same time are detached from its inner face by a blunt-pointed bistoury, or, if the periosteum is in a state to be preserved, by the elevator, peeling it off along with the other tissues of the floor of the mouth.

When the insertion of the internal pterygoid muscle is reached, it can be disengaged from the ramus with the same instrument, after which the jaw can be moved with much greater freedom.

Returning again to the external surface of the ramus, repeat the operation upon the masseter muscle and other soft parts up to the sigmoid notch, keeping close upon the bone. It remains now to detach the temporal muscle from the coronoid process, and the condyle from the external pterygoid muscle and the ligaments of the temporo-maxillary joint, in order to complete the disarticulation. This is by far the most difficult part of the task. It is desirable to avoid injuring the internal maxillary artery, which lies on the inside of the neck of the condyle. To effect these ends, let an assistant with a retractor draw the upper angle of the wound forcibly upward, while the surgeon, using the jaw as a lever, carries its horizontal arm strongly backward until the coronoid process appears below the zygoma and becomes accessible. While holding it in this position, he can pass a probe-pointed bistoury into the wound, and sever the tendon of the temporal muscle from behind forward. The detachment may also be accomplished by the elevator, the bone being turned in different directions, so as to present the different surfaces of the process to the edge of the instrument. The knife, however, is more expeditious.

The coronoid process once freed, the last step of the operation may be taken by carrying the jaws still farther back, causing the condyle to project strongly forward, when, its ligaments and the tendon of the pterygoid muscle being brought into view, they can be divided with the blunt-pointed bistoury, the first from before backward, the last from below upward. (Fig. 1644.)

When one-half of the jaw is taken away, the remaining half is liable to be drawn inward to a degree which interferes with mastication and the proper use of the tongue.

FIG. 1644.



Excision of the lower maxillary bone on one side.

The evil can be remedied by applying a denture between the jaws with caps to receive the teeth, thus making the upper jaw perform the office of a splint to the lower jaw.

When the disease stops short of the ramus, the bone may be sawed through immediately behind the angle.

Excision of the inferior maxilla.—In removing the whole of the lower jaw, it will be necessary to repeat the incision employed for unilateral excision, as already described, and, after denuding the maxilla at the symphysis, remove each half separately.

Barton proposed, when the disease did not involve the entire body of the maxilla,

to divide the bone horizontally with a saw, leaving a rim of osseous tissue answering to its lower border, and thus preserve the contour of this portion of the face. The suggestion is an ingenious one, but in malignant affections should not be adopted.

RESULTS.—Dividing excisions into three classes, Heyfelder has collected 286 cases, 188 of which recovered, 77 died or had a return of the disease, and in 21 the result was undetermined. Of 15 complete excisions,—and by "complete" is meant the removal of the inferior maxilla in its entirety,—14 were cured and 1 died; of 133 unilateral excisions, 90 recovered and 43 relapsed or died; while of 138 partial excisions, 84 recovered, 33 relapsed or died, and in 21 the result was unknown.

Hunter has collected 121 cases of resection of the lower jaw, 105 of which recovered and 16 died. Classifying these cases in a similar manner with Heyfelder's, there were 9 complete excisions of the lower jaw, with 6 recoveries and 3 deaths; 45 unilateral excisions, with 36 recoveries and 9 deaths or relapses; and 67 partial excisions, with 63 recoveries and 4 deaths.

Excision of the upper maxilla.—The removal—complete or partial—of the upper jaw is an operation very frequently demanded on account of different morbid growths both of the maxilla and of the antrum. Though forming the skeleton of so large a portion of the face, it is remarkable how slight is the deformity which follows the excision of an upper maxilla. When, in consequence of necrosis, the removal of the bone becomes necessary, the subperiosteal method should be employed, as a firmer basis of support will be obtained for the soft parts of the face, even though the new bone which is formed is imperfect and in isolated nodules.

The instruments necessary for the excision of the upper maxilla are one or two scalpels; two strong bone pliers, one straight and the other angular; a pair of lion forceps; and an Adams saw.

Complete excision of the upper maxilla.—The upper maxilla can be exposed in three ways, every one of which furnishes ample space for the exarticulation of the bone. The first, commonly known as that of Lizars, consists in cutting through the cheek by an incision carried from the angle of the mouth to the malar bone. In the second method, or that of Liston, the incision is made from the angle of the mouth to the external angular process of the frontal

bone. In the third, that of Fergusson, two incisions are made, one longitudinally, extending from the inner angle of the eye to the outer limit of the orbit, parallel with and a little below the infraorbital ridge, and the other commencing at the nasal extremity of the first, and carried down along the side of the nose, around its ala to the columnæ nasi, and from thence down to the middle of the upper lip. (Fig. 1645.)

FIG. 1645.



Incisions for removing the upper maxilla.

When employing the method of Lizars or that of Liston, care must be taken not to go to the anterior edge of the masseter, at a point on a line from the anterior naris to the lobe of the ear, otherwise the duct of Steno may be wounded. The incision which I employ is that of Fergusson, dividing the lip, however, not in the middle, but midway between the middle and angle of the mouth, as represented in the cut. When the lip is divided in the middle, there is apt to follow in the healing a little depression of the red border where, naturally, there should be a slight prominence; and this detracts from the appearance of the lip.

The advantages of the Fergusson incision are—first, the flap is below and out of the way of the operation; second, there is no danger to the parotid duct; third, the cicatrix, after healing, is in shade, and therefore less noticeable than when lying across the cheek; and, fourth, the arteries and nerves are severed near their extremities.

The operation may be divided into four stages,—namely, exposing the bone; separating it from its adjoining connections; wrenching it from its position; and closing and dressing the wound.

First stage.—Assuming, then, that the maxilla is to be extirpated by this plan, let the flap, as the first stage in the operation, be dissected up from the bone and turned down, while pressure is at the same time made by the fingers of an assistant upon the facial artery where it passes over the lower jaw. Several arterial branches in the flap will require the ligature, after which the soft parts are to be dissected away from the nasal process, and also the cartilage of the nose from the nasal notch of the maxilla.

Second stage.—After extracting the middle incisor tooth of the affected side, the malar bone should be severed close to its junction with the maxilla. This can be most conveniently done by the large bone pliers. If any difficulty is experienced, let the division be partially made with the saw and completed with the bone pliers. After effecting the disjunction of these pieces, a similar division of the nasal process is to be made, when the disease will admit, just below the groove in which lies the lachrymal sac. Two incisions are to be made over the hard palate, one posterior and transverse, separating the soft palate from the palatine bone, and the other extending from the inner extremity of the first along the longitudinal suture uniting the horizontal plates of the palate bones and the upper maxillæ to the alveolus from which the incisor tooth was extracted. The hard palate is now to be divided; and this can be accomplished either by the large straight pliers, one blade being introduced through the nose and the other through the mouth, or by inserting the saw through the nose and sawing through the plates of bones from behind forward. This is preferable, as it causes no comminution. In executing this part of the operation the saw follows the incision made through the soft tissues of the hard palate, and must not trench on the suture, the edges of which support the bony septum of the nose.

Third stage.—It only remains now to dislodge the bone from its bed and

from the pterygoid process of the sphenoid, against which it rests. After detaching the periosteum from the orbital plate of the maxilla with the handle of the scalpel, or with an elevator, and thus leaving a support for the ball of the eye, the surgeon seizes the jaw with his fingers, or, in the case

FIG. 1646.



Excision of the upper maxilla—the appropriate instruments applied to the parts requiring division.

of a tumor, with the lion forceps, and draws it strongly outward and downward, separating with the finger or with a blunt-pointed bistoury or scissors any remaining connections which the bone may have with the soft parts. (Fig. 1646.)

Frequently it will be found that the disease does not implicate the orbital plate of the bone; and when this is the case the latter should by all means be left. This is done, after dividing the nasal process, by introducing the saw into the opening and cutting the body of the bone away from the floor of the orbit by sawing along the infraorbital ridge to the malar suture.

Fourth stage.—Any hemorrhage which follows must now be attended to; but, if the operator has been careful, it is rarely necessary to apply more, perhaps, than one or two ligatures. I have, however, seen very profuse, even alarming, bleeding in the extirpation of the upper jaw. To avoid this, keep close to the tumor while the latter is being uncovered, and, after this is accomplished, attack the bone as far from the growth as possible.

In one case, that of Hewett, death was attributed to the blood flowing into the air-passages,—a doubtful explanation of the unfavorable result. In view of such a possibility, the operation of tracheotomy has been suggested as a preliminary measure to the excision. If the patient is allowed to come partially from under the anæsthetic, while the deeper connections of the jaw are being separated, and the mop is frequently used, no danger from this source need be apprehended. The ligature of the carotid artery as a preliminary measure, once practiced by Lizars, is not deemed necessary at present, and very rarely indeed is a resort to the hot iron required. The flap is now to be replaced, and stitched with the interrupted suture, introducing a single twisted one at the free border of the lip. A piece of lint moistened with carbolic acid and olive oil is next to be laid over the wound and kept in position by a light compress and a few strips of adhesive plaster. The mouth will require to be frequently washed out with warm water or chamomile tea, in order to remove the vitiated secretions. Union usually follows very quickly. The twisted suture can be removed about the third day, and the others about the fourth or the fifth day. The diet for the first four days ought to be restricted exclusively to milk, after which animal broths may be allowed. Should the face become much swollen, or assume an erysipelatous appearance, it should be treated by lotions of lead-water and laudanum.

Excision of both upper maxillæ was partially performed by Rogers, of New York, in 1824, but the entire removal of both bones was first executed by Heyfelder, in 1844. This operation does not differ in its details from that necessary for the removal of a single maxilla, except in requiring that the preliminary excisions for exposing the bones shall be made on both sides of

the face. The operation has now been reported ten times, including that of the above-named surgeon.

Partial excision of the upper maxilla.—When the disease is limited to the alveolar border of the bone, or when the orbital or palatine plates remain sound,—provided the disease is not malignant,—excision should be restricted to the affected part of the jaw, and may be carried into effect without dividing the cheek.

For example, when only the lower part of the body of the maxilla is affected, the disease may be removed by separating the cheek from the bone, and excising the latter to the required extent with the straight and curved pliers. With equal facility, by detaching the lip and the alæ of the nose, portions of the alveolus and palatine plates can be cut away.

In one instance, I removed before the medical class of the hospital of the University the entire upper maxillary bone, except its orbital plate, without any external incision. Professor Horner, in a case of cancer of the antrum, excised the maxilla entire, all the incisions being made within the mouth.

When the disease occupies the antrum, is benign, and of a nature demanding operation, no incision will answer better for exposing the part than one carried from the angle of the mouth to the zygoma, beginning at the upper border of the first, or one made along the anterior border of the masseter, stopping short of the duct of Steno, and a second along the lower border of the orbit, the two joining immediately behind the malar bone. In all cases of malignant disease of the upper maxillary bone, when an operation is determined upon, partial excisions are useless, the entire maxillary requiring to be removed; and even when this radical measure is adopted the recurrence of the disease may be anticipated.

Secondary hemorrhage has in a very few instances followed excision of the upper maxilla, as in a case under the care of Dr. Pancoast, in which the carotid was successfully tied. A similar case occurred to Mr. Wagstaffe, requiring the ligature of the primitive carotid, notwithstanding which the patient died.

The deformity which follows even complete excision of the upper jaw is by no means conspicuous, the void being filled up to a considerable degree with a formation of dense connective tissue.

When the tumor is malignant, and returns after excision, secondary operations are useless. They can do no good, as it is impossible to follow the disease into the different recesses and sinuosities which are in communication with the jaw.

In 36 operations of removal of the upper maxilla, including partial and complete excision of one or of both bones, which include the cases of Hutchinson, Esmarch, Braun, and Heyfelder, there were 85 relapses and deaths, 212 recoveries, and 64 terminations unknown. Classifying the excisions on the basis of the amount of bone removed, Hutchinson gives 17 cases of complete excision of the maxilla, with 14 recoveries; Esmarch, 10 cases, with 8 recoveries; Heyfelder, 141 cases, with 51 recoveries, 33 relapses, and 57 unknown; Braun, 11 cases, with 7 recoveries and 4 unknown.

Of partial excisions of one maxilla, Heyfelder has collected 153 cases, 48 of which were cured, 35 relapsed or died, and 70 were undetermined. The same surgeon has analyzed 11 cases of complete and 8 of partial excision of both maxillæ, 5 of the former class being cured and 6 relapsing or dying; in the last or partial class, 7 were cured, 1 relapsing and dying. Braun furnishes also the result of 5 cases of partial or consecutive excisions of the jaw for tumor and 7 for necrosis, all of the former recovering, and 6 of the latter.

Analyzing the cases collected by Hunter, I find that in 158 excisions of all kinds of the upper jaw, 128 recovered, 27 died, and 3 relapsed. In 12 instances in which the excision of both maxillæ was complete, 8 recovered, 3 died, and 1 relapsed; in 120 removals of one upper maxilla, 99 recovered

and 21 died; and of 24 partial excisions of the upper jaw, 20 recovered, 1 died, and 3 relapsed. As far as it was possible to follow out the history of those reported recovered after excision of both jaws, the disease recurred in one case after the lapse of one year, in a second after five months, and in a third after three months. In one which was seen a year after the operation, no return of the disease was noticed. The diseases for which the excisions were done were—carcinoma, 6; sarcoma, 3; fibroma, 1; and phosphor-necrosis and necrosis, each 1.

Of the 99 recoveries after removal of one upper jaw, 14 were known to have relapsed. The diseases for which the excisions were performed were for the most part sarcoma, carcinoma, and fibroma.

Post-Maxillary Tumors.—In examining the articulated skull, a space will be seen behind the tuberosity of the superior maxilla, between the latter, and the great wing and the pterygoid process of the sphenoid bone (sphenomaxillary fossa). This space communicates with the temporal region, with the facial region, with the orbit through the sphenoorbital fissure, and with the palate, pharynx, and posterior nares. Tumors may take their origin in the sphenomaxillary fossa, springing from any portion of its boundaries, and develop finally into any of the regions in communication with this space. The connections of the pterygoid fossa offer an obstacle to the extension of a growth in this situation downward into the neck. The secluded location of morbid growths in this fossa allows of their making considerable progress before being discovered. Some exceedingly ingenious osteoplastic operations for the extirpation of these tumors have been devised by Langenbeck, who has given to them much careful study.

The sphenomaxillary region can be entered by making one longitudinal incision along the lower border of the zygoma, commencing three-quarters of an inch in front of the ear, and terminating at the middle of the infra-orbital ridge; and another vertical incision, beginning on a line with the posterior part of the malar prominence, and extending from the first incision down to the level of the duct of Steno. The flaps are to be dissected and turned in opposite directions, when the origin of the masseter muscle and the zygomatic arch will be brought into view. The muscle is now to be detached from the latter and the malar bone, and turned down, after which, if the growth is of a nature requiring more room for its removal, the anterior portion of the zygomatic arch and the coronoid process of the inferior maxilla may be cut away.

Watson, of Edinburgh, entered the pterygo-maxillary fossa, and removed, successfully, a fibroma, by making an incision along the base of the inferior maxillary from behind its angle to the symphysis, and from thence through the middle of the lip, afterwards dividing the jaw and drawing it sufficiently to one side to give access to the pterygoid space. After the removal of the tumor, the ends of the jaw were united with wire.

Excision of growths which have entered the pharynx or the nasal fossa from this region will be considered with affections of the nose.

Cleft Palate.

The cleft left in the hard or the soft palate from failure in the two sides to coalesce is generally a congenital defect, and is often associated with hare-lip, and occasionally with perforation, though both are seen as a result of syphilitic ulceration and necrosis. Various degrees of the defect are met with. The simplest is a slight notch extending a little distance into the median line of the uvula; or the cleft may extend to the palate bone through the soft palate; or through the palate to the horizontal plates of the maxilla; or between the latter to the alveolus; or even through the alveolar process, either as a single fissure or a double V-shaped one, the intermaxillary bone being placed between the two branches of the V.

Not only have we all degrees in the antero-posterior extent of the cleft, but also in the width of the gap between its sides, which varies from a slight fissure to a chasm, and which may even practically bring the two cavities—oral and nasal—into one.

TREATMENT.—As cleft palate is often associated with hare-lip, it will be proper to close the latter before attempting more. If successful in this, the tension which results from the united lip will in a short time materially diminish the palatine fissure, and contribute to the success of an operation for its subsequent closure.

With regard to the proper age for making an attempt to close a cleft of the hard or soft palate, I do not believe that it can be undertaken with any encouraging prospect of success earlier than from the third to the fifth year. I have operated at all periods, from infancy to twenty-five years of age, and have learned by experience to avoid very early operations. While it is true that by the use of anæsthetics one of the great difficulties in the closure of palatine clefts has been removed, this does not obviate the evils which result from the want of vital resistance in the tissues concerned, the fretfulness, and the indisposition to swallow food, which may be expected in very young children who have been the subjects of this operation. I am not, however, in favor of waiting until puberty, as has sometimes been advised, before undertaking the operation. A delay of this duration only increases the defect in articulation, which persists in some degree even after successful closure of the cleft.

Nor must the general health be overlooked in estimating the probabilities of securing union in the parts. Staphylorraphy, more than any other operation, demands for its success an entire freedom from indisposition, and to attempt the treatment in defiance of this precaution is to subject the patient to a hopeless surgical procedure.

History of staphylorraphy.—The operation for the cure of cleft palate by paring the edges of the cleft was first proposed by Le Monier, a French dentist, in 1764; but it was not until 1819 that any practical advance was made towards the realization of the desired object, when Roux, the celebrated French surgeon, not only succeeded in effecting the first cure by surgical operation, but also formulated the rules for its performance. Nearly about the same time,—in 1820,—and altogether independent of Roux, Warren, of Boston, brought to the notice of the profession a similar operation, which in facility of execution was preferable to that of the French surgeon. These operations were followed in this country by those of Stevens, of New York, Mettauer, of Virginia, Wells, of South Carolina, Gibson, of the University of Pennsylvania, Hossack, the younger Warren, Mütter, and Pancoast; and on the Continent and in Great Britain by those of Graefe, Dieffenbach, Sédillot, Liston, Fergusson, and Pollock. In 1844, Fergusson made a very important improvement in the operation,—that of relieving the tension on the ligatures by the formal division of the levator palati, palato-pharyngeus, and palato-glossus muscles on either side. The division of the pillars of the fauces as a means conducing to union was not unknown even before the operation of Fergusson, as it had been suggested by Mettauer as early as 1837, and performed by the younger Warren in 1843.

As the tension of the palate is dependent in a large measure on the contraction of the circumflexus palati, a very marked relaxation will follow the division of the tendons of the muscle where they pass round the hamular processes of the sphenoid bone. This particular tenotomy I performed as early as 1860, in a young lady whose palate I closed with the assistance of Dr. Brinton, of this city; and I attributed the success of the operation to this procedure. The division was accomplished by carrying a narrow-bladed tenotome along the posterior termination of the alveolar process and the extremity of the outward plate of the pterygoid process of the sphenoid bone, and cutting directly upon the tendon of the circumflex muscle behind the hamular process. The late Mr. Pollock, of London, recommended the

same procedure, differing only in the direction of his incision, which was made on the inner side of the hamular process after carrying the knife through the soft palate.

OPERATION.—The operation of staphylorrhaphy on a person who has arrived at an age when the surgeon can secure the co-operation of the patient, though a tedious one, is not a difficult one, nor is it attended with sufficient pain to make it necessary to use an anæsthetic. The fauces, however, should be handled with a spatula frequently for a few days before the operation, in order to render the parts tolerant of the manipulations attending the closure. In young subjects nothing can be done without the use of an anæsthetic.

Quite a number of complicated contrivances have been devised from time to time for the performance of staphylorrhaphy, but in this, as in all other surgical procedures, the tendency to instrumental simplification increases with experience. The instruments which I employ are a gag, to keep the mouth open; a long pair of rat-toothed forceps, to hold the palate (Fig. 1647); a delicate, keen, double-edged scalpel with a long handle, to pare the

FIG. 1647.



Forceps.

edges of the cleft (Fig. 1648); two needles, standing at an angle with the handle, and having the eye near the point (Fig. 1649); a small hook, to dis-

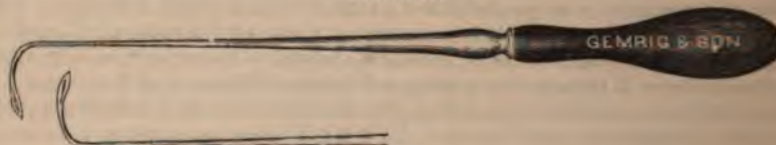
FIG. 1648.



Scalpel.

engage the loose thread from the eye of the needle; a pair of ordinary scissors; an adjuster (Fig. 1650), to tighten the wires and thus bring the freshened

FIG. 1649.



Needles.

sides of the chasm together; some fine silver wire for sutures; a few perforated shot; and a compressor, with which to clamp the sutures.

FIG. 1650.



Adjuster.

There are several forms of the gag, but the simplest is that figured on page 914. Indeed, the mouth can be kept open very well with a piece of cork having a cord attached and slipped in between the back molars. Only when the patient is a child is it necessary to use an instrument of the kind.

The operation may be divided into three stages,—namely, freshening the sides of the cleft, passing the sutures and dividing the muscles of the palate, and closing the wound.

The patient being etherized, and, if a child, placed in a semi-recumbent position, the jaws are to be opened with a gag. The surgeon now, taking his stand either behind or in front of the patient, as he finds most convenient, seizes with the forceps the extremity of the uvula on one side of the fissure, puts it upon the stretch, and then, transfixing it with the knife, pares away one side, cutting first upward and then downward, so as to remove from the fissure a thin strip of tissue, leaving a raw surface from the base to the apex of the cleft, after which the opposite side is to be treated in a similar manner. (Fig. 1651.)

The sutures, beginning above, should be about three-sixteenths of an inch apart, and, in order that they may not cut out prematurely, will require to be passed about a quarter of an inch from the borders of the fissure. In order that the silver thread can be readily detached from the needle, it should, after passing the eye of the instrument, be bent into a short hook.

The introduction of the threads is effected by passing the needle through the palate on one side of the cleft from before backward, and through the opposite side from behind forward. The passage is facilitated by stretching at the same time the parts with the forceps.

As soon as the point of the needle appears in front, the wire is disengaged from its eye with the hook and drawn through, after which the needle is withdrawn. (Fig. 1651.) After trying different plans for accomplishing this very difficult part of the operation, I find the above to be the easiest of execution.

As soon as the suture is in position, its two ends are to be twisted together and bent upon themselves, so as to retain them temporarily together. After all the stitches have been introduced, their ends are to be untwisted, and pressed, one suture at a time, through the opening in the adjuster. As the latter instrument is forced down upon them, the sides of the cleft are brought together and so held by the set given to the wire. Each separate suture is subjected to the same process, after which the ends are passed through a perforated shot, which is now forced down in contact with the line of approximation, and clamped with the compressor in the order in which the stitches were inserted,—that is, from above downward. To complete this stage of the operation, it remains to relieve muscular tension by the division of the anterior and posterior lateral half-arches.

When the space between the sides of the cleft is not great, and the tissues not scant, the myotomy may be withheld until the sutures have been inserted and permanently clamped; but when the reverse is the case, the division of the muscles must be made as soon as the edges of the fissure have been freshened. Fergusson's plan, to which reference has been made, was to pass a sickle-shaped knife through the cleft, near its apex, and, turning the point of the instrument against the posterior surface of the palate, cut directly downward, with a view to divide the levator palati, afterwards cutting through the palato-pharyngeus muscle. The levator palati is much less at fault than the circumflexus palati muscle, though the cut which divides the first will also sever the fibres of the last.

In most instances it will only be required to sever the anterior and posterior arches, which is most conveniently done by putting them on the stretch with a pair of forceps and dividing them transversely with curved scissors, opposite to the tonsils.

FIG. 1651.



Paring edges of cleft and introducing sutures.

When it is desirable to cut the circumflexus palati, palato-pharyngeus, and palato-glossus muscles, it may be effected by transfixing the velum above the point where it is joined by the arches, and cutting downward and outward, stopping short of the crescentic edges of the two pillars. (Fig. 1652.) What-

ever operation is adopted, the division must be made on both sides alike.

After-treatment.—The patient, after the operation, should remain quiet, avoiding all those movements which tend to disturb the parts, as laughing, yawning, and talking. The nourishment, consisting wholly of milk, beef-essence, and eggs, should be taken freely, in order to maintain the general strength of the system and thus conduce to the rapid healing of the wounds, while the secretions of the mouth and pharynx which adhere tenaciously to the palate are to be removed daily with a large camel's-hair brush. At the expiration of the eighth or ninth day the sutures may be removed by clipping out the wires in the reverse order of their insertion.



Fig. 1652.
Showing sutures clamped, and the division of the arches, the circumflexus palati, and the levator palati.

plates of the palate bones, it will be impossible to bring the edges at the upper angle of the soft palate in contact without detaching the latter from the palate bones. This can be done by means of a little instrument (Fig. 1653)

Fig. 1653.



Instruments for raising the soft tissues from the hard palate—two patterns.

which, being passed behind the velum and applied between the latter and the bone, will enable the operator to make the necessary separation, after which the edges, being freshened, may be brought together by suture.

If union fails at the upper angle of the wound, and a small opening remains, it may subsequently be closed by granulation; but to effect this it will be necessary to stimulate an abundant growth of granulation tissue by frequently touching the borders of the opening with tincture of iodine applied with a camel's-hair brush.

Affections of the Hard Palate.

Hypertrophy of the transverse ridges or bars at the anterior part of the hard palate may occur from contusions of the mucous membrane. The swelling resembles in some respects the disease which in horses is termed by farriers the "lampers." The thickening, should it not disappear spontaneously, can be removed by occasionally touching the bars with tincture of iodine.

Abscess of the hard palate is likely to follow contusion of the mucous membrane, and, less frequently, a misplaced tooth. The soft, fluctuating, and pointed character of the swelling will reveal the nature of the enlargement, the contents of which should be evacuated at as early a period as possible, to prevent separation of the soft tissue overlying the bone.

Vascular Tumors of the hard palate are exceptionally rare. They may be either erectile or aneurismal. Professor Gross mentions one of the latter kind which arose from a wound of the posterior palatine artery, and which was cured by laying open the tumor and tying the distal and proximal ends of the vessel.

Erectile tumors will resemble in appearance the angiomaticous growths of the gums or jaws already described. When small, and not growing, they may be allowed to remain without interference; if, on the contrary, a steady increase is observed, and the disease is circumscribed, excision and the actual cautery will be required. When the vascular growth is chiefly arterial, which may be determined by its florid color and its sudden distention under excitement, no operation should be undertaken which does not contemplate the excision of a portion of the jaw.

Papilloma, encephaloma, sarcoma, and enchondroma of the hard palate, in their symptoms, characteristics, and treatment, differ in no respect from tumors of the kind situated in other portions of the jaw.

Gangrene of the hard palate is a rare affection. It occurs only, so far as I know, in persons past middle life. The manifestations are unilateral, commencing in a livid discoloration of the mucous membrane at the posterior portion of the hard palate, near the angle of its junction with the alveolus, which advances forward and laterally, becoming gradually of a black color, and implicating both the gums and the other portions of the hard palate, but not transcending the limits of the palatine suture. The breath is stinking, being loaded with the gaseous products of decomposition. Almost immediately on the appearance of the gangrene, general symptoms arise. The pulse is feeble and frequent; the tongue becomes dark, dry, and is streaked in the middle with a strip of red. There is extreme exhaustion, accompanied by sweats, nausea, wandering, subsultus, and hiccoughs, and ending in death. Two cases of the disease which I attended, one in consultation with Drs. Fischer and Da Costa, and the other with Dr. Dallam, terminated fatally, the first, I believe, on the fifth and the other on the sixth day from the commencement of the attack. In neither was there opportunity for an autopsy; but the cause of the gangrene was in both almost certainly an obstructive clot in the posterior palatine artery.

The remedies employed in each of these cases were tonics, stimulants, milk, and animal broths, and at the same time disinfectant mouth-washes of permanganate of potash, dilute alcohol, etc.

Cleft in the Hard Palate.—Not unfrequently congenital clefts extend through the entire length of both the hard and the soft palate. This is an unfortunate defect, but in many instances is not beyond the pale of surgical treatment. Cases which should be excluded from operative measures are those in which the horizontal plates of the upper maxillary and palate bones remain in a rudimentary state, scarcely projecting beyond the alveolus. Even this unpromising condition is only a temporary one, as subsequent development of these portions of the bone may take place. When the defect is conjoined with hare-lip, an early operation for the cure of the latter should be practiced, as success in this respect will be followed by a marked diminution in the breadth of the cleft in the hard palate; if the fissure of the soft palate can be closed, even though only partially, the influence in lessening the chasm in the palatine suture will be still more marked.

Uranoplasty.—The process of closing palatine clefts is technically termed *uranoplasty*,—an operation for which the profession is indebted to Dr. J. Mason Warren, of Boston. The method of Warren, which was published in 1843, consisted in paring away the mucous membrane on each side of the cleft, and afterwards raising the same from the bones, as far outward as the alveolus, by means of a double-edged knife curved on the flat. After their

detachment, the flaps were slid over to the median line, and brought together by a number of interrupted sutures. Langenbeck, in performing this operation, made his incisions close to and parallel with the alveolus, subsequently raising all the soft parts from the palatine plates, including the periosteum, with an elevator. This operation is supposed to have some advantages over that of Warren, as it is believed to endanger the vitality of the flaps less, including, as it does, all the soft tissues covering the bone; it also takes advantage of the osteogenetic function of the periosteum, and may result in bridging the chasm with new bone.

There is some force in the last observation, but not in the first, as the division of the branches of the posterior palatine artery, and their separation from the flap when it is slid over in the direction of the fissure, increase the risks of sloughing,—an occurrence which has frequently defeated the success of the operation. Sir William Fergusson, in 1873, carried into practical operation a method which the ingenious Dieffenbach had suggested more than a quarter of a century before, that of cutting through the hard palate in its entirety, and, after moving the longitudinal sections into contact with each other, securing them together by silk sutures. His plan of carrying into effect this procedure is as follows. The edges of the fissure in both the hard and the soft palate are first pared. With a brad-awl two or more perforations are next made through the hard palate on each side of the cleft, about one-eighth of an inch from its borders, and directly opposite each other. Through these openings threads are passed and loosely secured. An incision is next made on each side down to the bone, close to the alveolus, and through the whole longitudinal extent of the hard palate. Along these incisions the bone is divided by means of a chisel, after which, by tightening and tying the ligatures, the two sides of the cleft are brought into contact. This part of the process is much more conveniently executed by means of a silver wire in place of thread and the soft clamp. (Fig. 1654.) In order to pre-

vent comminution, Mason, in 1874,* suggested perforating the bone at several points in the course of the lateral incisions before applying the chisel. This will tend to diminish the risks of necrosis. After the palatine plates have been adjusted and permanently fixed by the stitches, the operator introduces and secures the sutures of the soft palate; or, if the patient is too much exhausted, the closure of this part of the cleft may be left for another operation. The hemorrhage from the division of the posterior palatine vessels is quite free, and should be checked by introducing narrow pledgets of lint into the lateral cuts.

Should the palatine process be attached to the vomer on one side, as is sometimes the case, it must be separated by the knife or chisel as a preliminary step to the operation; otherwise the freshening of the cleft on that side cannot be done, nor

can the two palatine processes be reduced to the same level for the purpose of adjustment.

The same rules in reference to quiet and nourishment are to be observed after these operations on the hard palate as after those performed on the velum. The pledgets of lint introduced to control bleeding may be removed in about forty-eight hours, and the sutures in the course of from four to six days, depending altogether on the firmness of the hold and the absence of all undue irritation.

The adoption of any particular operation in these cases must be determined by the individual peculiarities. When only of moderate extent and with thick soft parts overlying the hard palate, Warren's operation is to be pre-



FIG. 1654.
Fergusson's method of closing a palatine cleft by osteotomy.

* *Surgery of the Face*, p. 107.

ferred; but when the chasm is large and the mucous and submucous tissues are thin, the method of Fergusson is preferable. It is also important to say that in very narrow fissures of the hard palate, pressing the jaws frequently towards each other will finally bring the sides of the cleft together without a resort to the knife; and the same result is favored by a successful closure of the gap in the soft palate.

Another operation—one recommended and successfully practiced by Dr. Garretson, of this city—consists in freshening the margins of the cleft, and then applying to the jaws a horseshoe-shaped clamp similar to that of Hainsby, and, by means of a screw, forcing the sides of the cleft together at once. This is entirely feasible in the young bone and when the fissure is narrow. The child should be etherized during the operation, and after the removal of the clamp, in order to retain and perpetuate the advantages gained, two stout compresses are to be placed, one over each cheek, below the malar bone, and kept in position by means either of a rubber ring slipped over the head of the patient, or of a small hard-rubber truss, the spring resting on the top of the head, and the pads over the buccal compresses.

MECHANICAL TREATMENT.—When unable to close a palatine cleft, either in consequence of indisposition on the part of the patient to submit to an operation, or from intractable conditions connected with the defect, the evil can be greatly remedied by mechanical appliances, of which the best is the very ingenious one constructed by Dr. N. Kingsley, of New York. It is formed on a principle conceived by Mr. Stearn, of London. Dr. Kingsley exhibited this obturator to me shortly after he had succeeded in bringing it to a successful completion. It consists of a gold plate, moulded to fit the hard palate, and to which is attached, by springs, a flexible piece of rubber fashioned so as to fit the margins of the cleft, and also to imitate, in form and function, the soft palate and the arches of the fauces.

Perforations of the soft and hard palate frequently occur as a result of syphilitic ulceration and necrosis. Those in the velum can be closed by vivifying the margins of the orifice with a bistoury, drawing the sides into contact by sutures, and, if necessary to relieve tension of the ligatures, making an incision into the palate on each side of the wound.

When there exists a perforation in the hard palate, an obturator can be prepared which will not only prevent the intrusion of particles of food into the nose, but will also restore the natural tone of the voice and articulation.

These obturators are constructed of gold or hard rubber by the dentist, and should never enter the perforation, otherwise its size will be increased.

Affections of the Fauces.

Elongation and Hypertrophy of the Uvula.—The uvula, particularly in patients subject to inflammation of the tonsils and arches, is frequently the subject of catarrhal disease, causing either œdema of the submucous connective tissue, or, when of a chronic nature, giving rise to plastic deposits which increase the bulk of the entire body of the parts. There is also an elongation or lowering of the uvula which is altogether independent of any inflammatory cause, being brought about either by general relaxation of the muscles of the velum from local or constitutional weakness, or by paralysis, as is often witnessed in diphtheria.

When the elongation or the œdema is due to an acute attack of faucial inflammation, the uvula presents an intensely red and swollen appearance in addition to its increased length,—often resting on the tongue,—and there is usually considerable soreness of the throat and more or less discomfort in swallowing. Frequently a little transparent bladder of mucous membrane will be seen below the muscular tissue of the body, dissected off from the latter by the serum, which gravitates to the most dependent part. The patient experiences an irritation at the root of the tongue, and often complains of the constant inclination to swallow something. Hypertrophy of the uvula

may be readily recognized by the general enlargement as well as elongation, —the latter being the result of the former,—and by the dense fleshy consistence of its structure.

Elongation merely from muscular relaxation can be distinguished from other forms of the affection by the natural shape of the uvula and by the diminished size of the isthmus of the fauces.

Paralytic elongation, whether from diphtheria or from cerebral compression, is associated with a similar state of the velum and arches, occasions a snoring or stertorous noise in sleep, and allows fluids to regurgitate through the nose when deglutition is attempted.

The evils resulting from chronic elongation or dropping of the uvula are irritation and congestion of the fauces, which may finally extend to the larynx, and a worrying, hacking cough.

TREATMENT.—Acute elongation of the uvula, such as commonly belongs to catarrhal attacks of the fauces during cold, damp, and changeable weather, and in good constitutions, generally yields in a few days to a cathartic, astringent gargles, and an anodyne at night. When it manifests a disposition to linger after the other symptoms have disappeared, a ten-grain solution of nitrate of silver, applied with a camel's-hair brush once or twice a day, will generally effect in a short time the reduction of any undue fullness of its vessels, and secure the absorption of whatever inflammatory products may remain.

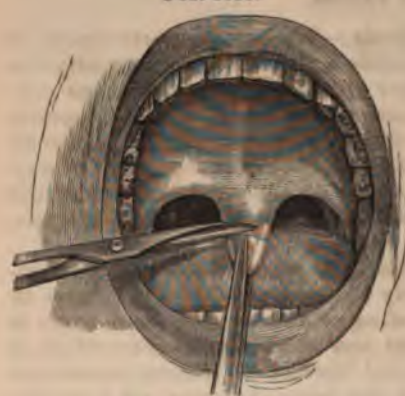
Hypertrophy of the uvula may be reduced by an application of the compound solution of iodine once every second day to the parts; this should be continued for several weeks, unless they become sore, when it may be suspended until the inflammation subsides, and then be resumed.

General relaxation of the muscles of the velum, uvula, and arches must be treated by tonics, to which strychnia is a valuable addition, by electricity, and by employing all general agencies capable of invigorating the constitution, as fresh air, wholesome food, sea-bathing, etc.

Relaxation and elongation of the uvula and palate caused by diphtheria or cerebral paralysis can only be remedied in the former disease by tonics and time, eliminating the poison from the blood, and rendering that fluid suitable for the nourishment of the nerve-centres, and in the latter by removing the cause of brain-pressure.

Removal of the uvula.—The structural alterations which follow inflammatory attacks frequently repeated render it necessary in many cases to excise a portion of the uvula.

FIG. 1655.



Excision of the uvula.

The operation is simple, and attended with no inconvenience whatever. Even the entire uvula may be taken away without interfering in the least with the voice or the functions of the palate. Such a mutilation, however, is never demanded, and would therefore be an unnecessary sacrifice of tissue.

If the elongation is œdematous, it will only be required to strip off the little sac of mucous membrane at the tip of the uvula to effect a cure. But when arising from thickening, or from a combination of both the latter and infiltration, it will be necessary to remove from a quarter to one-third of the process.

Excision is accomplished in a few seconds by seizing the extremity of the uvula with a pair of long rat-toothed forceps, putting it on the stretch, and severing by a single stroke with the scissors the amount necessary to be

removed. (Fig. 1655.) The after-treatment is very simple, requiring only the use of a gargle of alum-water.

Affections of the Velum Palati.

Inflammation of the soft palate presents the same general appearance as that of the uvula and arches, to which allusion has already been made, is induced by the same causes,—generally catarrhal,—and demands the same treatment.

Wounds of the velum are sometimes produced by sharp-pointed sticks, which, while being held between the teeth, have been forcibly driven into the mouth by an accidental fall. Gunshot wounds of the soft palate are sometimes inflicted by firing into the mouth in attempts at self-destruction, and also are among the possible contingencies of war. I have never seen an accidental incised wound of the velum. An injury of the character first named, which would be a lacerated wound, will, unless very extensive, heal without surgical interference, requiring only the use of astringent washes, applied with a large camel's-hair brush, to allay the inflammatory irritation; while those caused by fire-arms will necessarily slough, followed by an increased loss of substance, which subsequent granulation cannot wholly repair, and which may require an operation to close. Incised wounds may also be left to natural processes, with the prospect of the opening being finally united by granulations. If, however, the division is extensive, and in a direction which is followed by much gaping, it should be sutured, as in a case of cleft palate, the after-treatment being also the same.

Ulceration of the soft palate is rarely witnessed except as the result of syphilitic disease. The ulcers are often preceded by a patch of dark-red or purple inflammatory discoloration, which is soon followed by a superficial break in the mucous membrane, and, finally, by the formation of an unhealthy ulcer, incrustated with a gray layer of necrosed connective tissue. The destructive process often advances with such rapidity that in a few days the palate is completely perforated.

The diagnosis of such a sore is not a matter of any difficulty. On inquiry there will be discovered other manifestations of constitutional syphilis.

TREATMENT.—Treatment, when promptly and boldly adopted, will in most cases change the specific character of the sore, converting it into a healthy ulcer, which soon undergoes repair. The iodide of potassium is our sheet-anchor in a case of this kind. Mercury is too slow. The salt must be given in five-grain doses, largely diluted, every three hours, until the morbid action is arrested and the ulcer commences to heal, when the intervals of administration can be increased in length. I much prefer this plan to that of giving large doses at distant intervals.

Gummata are less common on the soft than on the hard palate. They commence as oblong, painless, and doughy swellings, are tardy in their progress, and are never present independent of a syphilitic history.

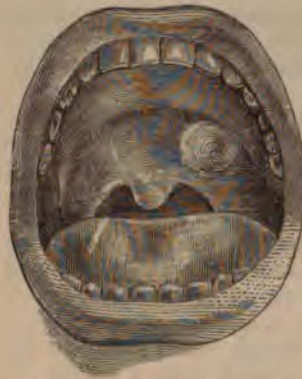
The treatment is the same as that employed for ulceration.

Abscess of the soft palate is an exceedingly rare affection. A soft acuminated swelling, having a purple-yellow color, would be a sign of a purulent collection, and its treatment would not differ from that proper for an acute abscess in other localities, namely, the use of heat and moisture, which, in this situation, will be best applied by the vapor of hot water drawn into the throat; as soon as the evidences of pus are established, the abscess should be evacuated with a bistoury.

Tumors.—The abundance of glandular tissue in the structure of the soft palate will explain the occasional development of an adenoid tumor in this

situation. It is most commonly met with in young people with strumous organizations; is oval in figure, sharply or abruptly defined at its circumference; is elastic to the touch, and painless. (Fig. 1656.) The growth might

FIG. 1656.



Adenoid tumor of the velum.

be confounded with a cyst or a gumma. A cyst, however, is spherical, salient, and semi-transparent; and a gumma, being associated with other evidences of syphilis, is not seen at so early an age as the adenoid tumor.

These growths, by their volume, may interfere with deglutition. The remedy is excision. In cases of adenotic hypertrophy of the post-nasal and palatine regions, as in old cases of catarrh, the entire soft palate may undergo a general thickening from a participation of its glandular element in the disease. This thickening, while primarily limited to the glands, ultimately extends, involving the entire velum by an inflammatory infiltration through all its tissues.

The local treatment of such a condition must begin in the regions above and behind the soft palate,—to be hereafter described in connection with diseases of the nose,—by the application of nitrate of silver, solutions of iodine, chromic acid, and accompanied with the alternate internal use of Lugol's solution, iodide of iron, Donovan's solution, and cod-liver oil.

Cysts of the soft palate may occur in connection with, or independent of, an adenoma. They are round, tense, often slightly yellow, elastic growths, with walls which in time become so attenuated as almost to disclose their contents. They vary in size from a pea to a cherry. The fluid which they contain is either a glairy mucus, like the white of an egg, or a straw-colored liquid, sometimes thin, at other times almost gelatinous in consistence.

These tumors are to be excised, and if a portion of the sac is allowed to remain, it must be treated either with the compound solution of iodine or with the solid nitrate of silver.

Carcinoma of the soft palate is, unfortunately, too common. Several times within the last few months have I had patients under my care, victims of this horrid disease. The form of cancer may be either epithelial or medullary. They can be distinguished from each other, especially at an early period, by appearance, progress, and accidents. Epithelial cancer appears, after ulceration begins, as an irregular-shaped sore, with jagged edges, showing no disposition to heal, progressing slowly but steadily, and not manifesting much tendency to bleed. Encephaloid carcinoma commences as a tumor, progresses rapidly, soon ulcerates, and fills the mouth with foul bleeding granulations, the secretions from which soon contaminate the fluids of the body and impress on the face the characteristic cachectic expression. The lymph glands beneath the jaw and the neck become involved more quickly in the encephaloid than in the epithelial form of the disease. Cancer often commences on the alveolus, the floor of the mouth, or the cheek, and extends to the arches and the soft palate. The disease is incurable, death taking place either in consequence of repeated hemorrhages, or from the exhaustion incident to general blood-infection.

Hopeless as are these cases, much may be done by the surgeon to alleviate the suffering of the patient by directing that the mouth be frequently washed out with a decoction of *rhus glabrum*, with dilute alcohol, and, when there is much tendency to bleeding, with a mixture of Monsel's solution of iron with water, or a hot solution of alum and water. Pain must be relieved by opiates, and the strength supported by liquids rich in the elements of nutrition.

Fibroma.—Fibrous tumors of the soft palate, described as polypi, are occasionally seen. They have a firm consistence, with an attachment sometimes pedunculated, at other times more sessile, and require excision.

Affections of the Tonsils.

Foreign Bodies may become lodged in the recesses of the tonsils and excite considerable irritation, which is often referred to the top of the larynx. Among these may be mentioned pins, needles, tooth-picks, and fish-bones.

To examine the fauces and tonsils, the patient should be placed before a proper light, with the mouth open, and without protruding the tongue, and should be requested to take a full inspiration. Or, if the parts are not too irritable, the tongue may be depressed so as to give a still more satisfactory view, using a spatula or a depressor. Resorting to a measure of this kind, any foreign body can be readily detected by the eye and extracted with an ordinary forceps.

Hardened Secretions and Calculi.—The tonsil is allied in its histological elements to both the sebaceous and the lymph glands,—the sebaceous portion of the organ being superficial or faucial, the lymphatic being deep and cervical. Frequently from errors of the digestive apparatus the follicles become blocked up with an inspissated secretion, consisting of fatty and earthy matters, together with epithelial detritus, the decomposition of which is a common source of an unpleasant breath. Chalky concretions, the so-called calculi of the gland, composed chiefly of phosphate and carbonate of lime, are also found imbedded in some of the recesses of the gland, the tendency of which is to excite irritation and inflammation of the tonsil. These conditions can be detected by the eye and the touch. To remove the cheesy masses of inspissated secretion will require pressure with the finger, aided by alkaline gargles, while the extraction of cretaceous calculi will be best effected by the forceps or the scoop.

If the concretion is large, or if several are present, it may become necessary to open or excise the gland.

Parasitic Cysts are among the very exceptional affections of the tonsils. Dupuytren once laid open a tonsil for what he supposed was an ulcer, but which proved to be a hydatid cyst; and Davaine, as recorded by Mackenzie, met with a similar case, in which the sac contained a trichocephalus.

Tonsillitis, or Quinsy.—Acute inflammation of the tonsils is most common in persons between the ages of twenty and thirty. In Philadelphia the disease prevails mostly during the winter months, and is generally caused by exposure in cold, wet, or damp weather. There are two well-recognized forms of tonsillitis, the superficial and the general, or the follicular and the parenchymatous.

SYMPTOMS.—Follicular tonsillitis is generally ushered in with a chill, followed by fever, a high temperature, thirst, headache, and general *malaise*. These symptoms are quickly followed by stiffness and dryness of the throat, slight hoarseness, tenderness to pressure made behind the angle of the lower jaw, painful deglutition, a more or less nasal tone of voice, general stiffness of the neck, and a tough, stringy mucus constantly collecting in the fauces.

In parenchymatous tonsillitis these symptoms are greatly intensified: the tonsils are much swollen, perhaps touching each other and obstructing the fauces; deglutition is almost impossible; the swelling extends to the arches and soft palate; the secretions, profuse, tenacious, and slightly yellow, keep the patient constantly hawking with a pharyngeal sound in order to dislodge the accumulations; while the neck, stiff and helpless, is held in a fixed position. Follicular tonsillitis rarely lasts beyond three or four days, and tends

to resolution, while the deep or parenchymatous form of the disease tends to suppuration.

TREATMENT.—In the simple or follicular variety, in which the inflammation does not penetrate deeper than the sebaceous crypts of the glands, little is required beyond rest in-doors, a hot foot-bath, a gentle cathartic, with an astringent gargle, consisting of a decoction of the berries of the *rhys glabrum* containing some chlorate of potash, or a similar preparation made from the bark of the pomegranate, or, finally, the old domestic gargle of sage tea, borax, and honey. These, with a Dover's powder at night and abstinence from food, will almost always suffice to induce a rapid resolution of the disease.

In parenchymatous tonsillitis much depends on an early use of remedies. At the commencement of the attack, if the patient is strong and vigorous, leeches should be applied below and behind the angles of the jaws. Free scarification of the glands with a bistoury may also be practiced. The local abstraction of blood is always followed by marked relief. Next in importance—some will say first in importance—is the use of guaiacum.

The value of this remedy admits of no question. It should be given internally and also applied externally. Internally, it can be administered in the form of a lozenge, each containing three or four grains of the powdered gum, and one of them allowed to dissolve in the mouth every two or three hours, or it may be exhibited in the form of an emulsion, each teaspoonful representing a like number of grains. The local application of the drug will be best obtained by using the ammoniated tincture of guaiac, which may be added to one of the gargles already named. The patient may also be allowed the frequent use of small pieces of ice in the mouth. As the proper use of gargles in severe cases of quinsy is impossible, the local application of remedies can be made in other ways. Thus, a solution of nitrate of silver may be brushed over the swollen tonsils, or a solution of tannic acid, alum, or nitrate of silver can be addressed to the parts by either a steam or a hand atomizer. The same substances can be applied by insufflation. A very good instrument for the purpose is that represented in Fig. 1657. The agent used is introduced into the tube, and driven from its cribriform extremity by pressing the gum air-bulb at the other end of the instrument.

FIG. 1657.



Insufflator.

When these remedies fail, or when the disease has not been early combated, and it is apparent that suppuration will follow, the process should be encouraged by applying hot flaxseed poultices about the throat, and directing the frequent inhalation of the vapor from hot water containing a little laudanum or chamomile tea. The simplest inhaler is an ordinary tin cup containing the hot liquid and covered by an inverted funnel, the steam being drawn through the neck. For the same object a rubber hose can be slipped over the spout of a teapot, and the vapor conducted through the tube into the throat. The physician should frequently examine the throat for the signs of pus, which may be detected sometimes by the eye, but more certainly by the conjoined pressure of two fingers, one on the swollen gland and the other beneath the angle of the jaw on the outside of the neck. As soon as a rigor or other symptoms announce the formation of pus, it should be liberated by puncturing the most prominent portion of the swelling with a sharp-pointed bistoury, and if successful in reaching the purulent collection the relief will

be instantaneous. In opening the abscess it must not be forgotten that the internal carotid artery lies at the base of the tonsil, and might easily be wounded if the point of the bistoury were allowed to penetrate the gland too far in the direction of the neck. The abscess, when it seeks the surface, points, as a rule, either anteriorly or internally. This, however, is not always the case; and the possibility of the pus taking a different direction should create a proper anxiety in the mind of the surgeon.

A young student of medicine while attending the Jefferson Medical College was attacked with parenchymatous tonsillitis. He had been ill several days before I saw him. My visit was in the night, when I found him suffering severely. An examination of the throat satisfied me that suppuration had occurred, and that the abscess was pointing posteriorly. I proposed to open the tonsil immediately; but, notwithstanding my representation of the danger of delay from the relation of the larynx to the abscess, he declined to have the incision made, preferring to wait until the morning. I left the house, but had not gone two squares, when he suddenly sprang out of the bed, fell on the floor, and expired in a few moments. The sac had burst and poured its contents into the windpipe, destroying his life by suffocation.

When the pus is deeply situated, if not liberated, it may travel into the neck. Roche mentions a case of this kind in which the abscess followed the course of the cervical vessels into the thorax, and Maller and Norton each one in which the coats of the carotid vessels became eroded by the abscess and the patients died from hemorrhage.

Hypertrophy, or enlargement of the tonsils, is an exceedingly common affection. While occasionally seen as the result of repeated attacks of quinsy, it is in most instances only one of the evidences of a strumous state of the general system. The enlargement is most common between the ages of five and ten, though it may be congenital. Cases of this hypertrophy among adults are only examples of a condition which began before puberty. Males are somewhat more liable to suffer from this disease than females. Frequently the subjects of this enlargement present other evidences of a constitutional vice, as tarsal ophthalmia, catarrh of the nasal mucous membrane, or eczema of the scalp. Not unfrequently the hypertrophy is traceable to an attack of measles or of scarlet fever. These affections, however, are only the exciting, not the remote, cause of the disease, which, indeed, is rarely encountered unconnected with a constitutional vice.

SYMPTOMS.—The signs of enlarged tonsils are sometimes so characteristically impressed on the face and voice of a child that the existence of the disease may be predicated on these alone, even before making an ocular inspection of the throat. The eyebrows are drawn up, the mouth is open, the face lengthened, and the voice nasal. When the throat is examined, the glands are seen as conical or spherical bodies projecting into the isthmus of the fauces, beyond the free borders of the arches, and often almost touching each other in the middle line. These bodies, when enlarged, vary somewhat in appearance. While in some the surface is broken by a series of intersecting ridges, in others the most noticeable characteristic is the number of enlarged follicular recesses or cavities which exist. Their color is red, often with a tinge of blue.

Evil effects.—The evils which attend typical cases of hypertrophied tonsils are not a few. They extend to the respiratory, digestive, and nervous systems, and often to the organs of sense. As the glands enlarge, they interfere so much with the free passage of air from the posterior nares to the larynx that the patient is compelled to keep the mouth open, in order to offer an additional route for the atmosphere to reach the lungs. For the same reason, breathing during sleep is labored, noisy, and snoring, so that the child rises in the morning dull, heavy, and unrefreshed, in consequence of the imperfect aëration of the blood in the lungs. Added to these evils is that of frequent attacks of tonsillitis, each one leaving an additional infil-

tration, which adds to the bulk of the gland. The hearing is also rendered dull, not from pressure of the enlarged tonsil on the Eustachian tube (which is anatomically impossible), but from the congestion and chronic inflammatory thickening of the tissues around its orifice.

A change in the shape of the thorax has also been recognized among the alterations of structure accompanying this hypertrophy. This has been specially studied by Shaw and Lambron, its principal feature being found to be a constriction or narrowing of the walls of the thorax corresponding to the insertion of the diaphragm, and giving rise to one form of the "pigeon-breast." This is due to the increased activity of the diaphragm rendered necessary by the faucial obstruction to the entrance of air. It is not difficult, therefore, to understand why children who are the subjects of marked hypertrophy of the tonsils should be dull and spiritless, indisposed to romp and play with their companions, and unable to accumulate flesh and strength.

PATHOLOGY.—The morbid condition consists in a hyperplasia of all the anatomical constituents of the healthy gland (Fig. 1658), connective tissue, mucous and lymph follicles, and blood-vessels. (Fig. 1659.) The structure of the tonsil may be tough and leathery in consistence, or quite friable, breaking down easily under the pressure of the fingers. Lodged in the recesses of the gland will often be found highly offensive cheesy casts or moulds of inspissated mucus, and also masses of cretaceous material.

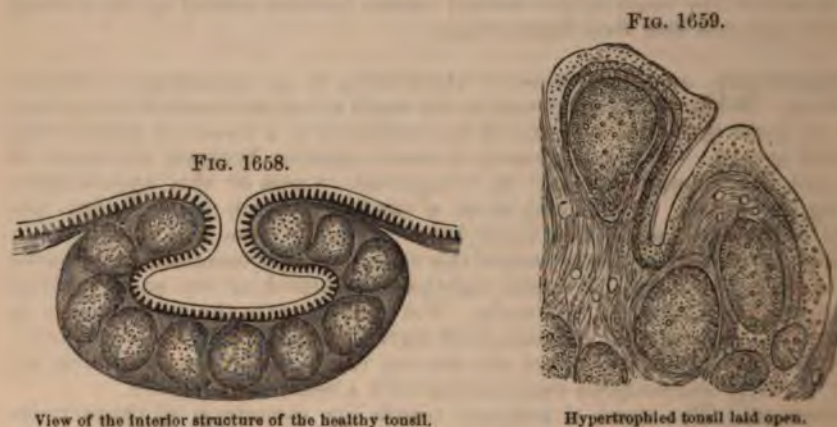


FIG. 1658.

View of the interior structure of the healthy tonsil.

FIG. 1659.

Hypertrophied tonsil laid open.

TREATMENT.—The treatment is topical, general, and operative. In many cases the size of the tonsils is so inconsiderable that no treatment of any kind is required. They may grow somewhat, or remain stationary, until after puberty, when they spontaneously diminish in size. In others, again, while they are not sufficiently large to give rise to difficulties of respiration and intonation, they are a constant source of irritation, and predispose the person to frequent attacks of sore throat, in which the glands participate. There are cases which can be greatly benefited by the systematic use of astringents, among which none have afforded me better results than powdered alum, or the compound solution of iodine, rendered as bland as possible by the addition of a little powdered loaf-sugar and gum acacia. The alum should be plastered over the tonsils, every night and morning, with a large camel's-hair brush well loaded with the powder. The iodine, when employed, can be brushed over the parts in the same way, once every second day. When the child is pale, thin, and without appetite, iodide of iron in pill form, cod-liver oil, and bathing will prove important adjuvants.

OPERATIVE MEASURES.—However valuable as a palliative may be the treatment detailed, it can have little influence in reducing the hypertrophy of the gland; and when this is sufficiently great to occasion the evils which have been enumerated, nothing will avail but the removal of the redundant

portion of the tonsil. This can be effected in two ways,—by caustic and by excision.

Caustic.—Many persons are indisposed to allow the use of the knife, and will foolishly permit their children to suffer rather than surrender their judgment to that of the medical attendant. Out of mercy to the child, it is better, under such circumstances, to submit to their prejudices and resort to caustics.

Mackenzie is partial to the London caustic, which consists of caustic soda and quick-lime; and it certainly is the most manageable and altogether satisfactory member of the class. A little of the powder should be mixed with some water to the consistence of thick cream, and then applied by means of a wooden spatula to the tonsil at two or three points, and only to a very small portion of the surface at each. The patient should in three or four moments wash out the throat with a gargle of plain water, in order to remove the redundant paste. A slough will follow the application at each point, and by repeated applications the tonsil may finally be very much reduced in size.*

Donaldson, of Baltimore, effects the same end by making punctures or incisions into the gland and introducing for a few moments a crystal of chromic acid. The tonsil can be destroyed in the same way, and more quickly, by making two or three openings with a bistoury into its substance, and as soon as the bleeding subsides introducing a like number of arrows composed of the chloride of zinc. The action of this caustic is quite painful, and, it being deliquescent, the mouth and throat should be frequently washed out for the first twenty-four hours after its introduction. Injections of iodine, ergotin, and carbolic acid have also been practiced.

Cohen, of Philadelphia, has succeeded in partially removing the hypertrophy by electrolysis frequently repeated. The battery employed consisted of forty cells, and the application was by a long platinum needle, connected with the negative pole and inserted into the gland, while a sponge electrode, in connection with the positive pole of the battery, was applied over the neck, below the angle of the jaw.

Excision.—The operation by excision is so simple, painless, and expeditious that, unless there is some cogent reason to the contrary, as, for example, a hemorrhagic diathesis, it should always be preferred. It was practiced in the time of Celsus, as also was avulsion with the fingers. Afterwards it seems to have fallen into desuetude, being alternately revived and condemned, until 1740, when Richard Wiseman, among English surgeons, popularized the operation. Ligating the tonsils was resorted to by Sharp and Cheselden, sometimes by the single and at other times by the double ligature.

The great dread in excision seems to have been hemorrhage: hence the precaution observed by Paré, Wiseman, and others, of encircling the gland with a ligature before excision with the bistoury. That this precaution was entirely unnecessary was afterwards shown by the French practice at the Hôtel-Dieu, Rheims, in 1757, when these glands were frequently and safely removed with the bistoury. Even as late as the time of Physick, who practiced the method, strangulation with a canula and wire (the operation of Bebrach) was often employed in the removal of enlarged tonsils.

OPERATION.—Excision of the tonsils can be accomplished by the vulsellum forceps and bistoury, or by some of the various tonsillitomes. The operation must never be attempted when the glands are inflamed, otherwise a dangerous bleeding may ensue, or possibly sloughing.

If the knife is employed, the patient should be seated before a good light, and, while the mouth is wide open, and, if required, the tongue pressed down by an assistant, the surgeon seizes with a clean vulsellum the projecting portion of the tonsil, and, drawing the latter inward and forward, amputates, in a downward direction, with a curved probe-pointed bistoury, all that portion of the gland which is on a level with the concave borders of the arches.

* Mackenzie, *Diseases of the Throat and Nose*, vol. i. p. 71.

It is never necessary to carry the incision nearer to the base of the tonsil than this. Both tonsils, when requiring it, should be removed at the same sitting.

Generally the hypertrophy of these glands is not equally great: when this is the case, and the smaller of the two extends only a little beyond the pillars of the fauces, it will be sufficient to excise the major one alone. A little bleeding follows the operation, which soon ceases, or is readily controlled by gargling the throat with ice-water. The after-treatment is very simple, requiring confinement to the room for four or five days, and the use of a gargle of catechu and alum, or one of flaxseed tea containing a little tincture of myrrh.

A very excellent mode of removing the tonsils is by an instrument styled a tonsillitome. There are several forms of the instrument, but the best, in my judgment, are those of Fahnestock, a physician of Lancaster City, and of Physick. Both consist of a ring composed of two plates, between which slides a knife with a stylet in front.

In Fahnestock's instrument (Fig. 1660) the knife is circular, and cuts by being retracted.

FIG. 1660.



Fahnestock's tonsillitome.

In the tonsillitome of Physick the knife is fashioned like a chisel, and cuts by being pushed forward. (Fig. 1661.) Both act well; but I prefer that of Fahnestock.

FIG. 1661.



Physick's tonsillitome.

It is essential to the satisfactory use of either that the knives have a very keen edge.

In removing the tonsil by these guillotines, the ring is slipped over the

FIG. 1662.



Kolbe's tonsillitome.

hypertrophied growth and pressed well back towards its base; the stylet is then thrust forward, transfixing the body of the gland, when the knife is

quickly drawn back or pushed forward, according as the instrument of Fahnestock or of Physick is employed, when the projecting portion of the tonsil will be severed, and comes out, fastened to the stylet of the tonsillitome.

Another very ingenious instrument of the kind is the tonsillitome of Kolbe, which combines in one movement both the fixation and the excision of the gland. (Fig. 1662.)

Though excision is not a painful procedure, yet, in consequence of not being able to obtain the co-operation of patients who are too young to understand what is to be done, an anæsthetic can be given with great advantage.

Hæmorrhage to any great degree after excision is quite uncommon. I can recall but a single instance in my own experience in which any anxiety was experienced from this cause. There is a condition of the gland which predisposes to bleeding. It is one due to the presence of chalky concretions, or of dense connective tissue, to which the vessels become adherent, and by which their walls are prevented from contracting. When the bleeding shows a disposition to continue, a strong solution of gallic acid, or a hot solution of alum, should be slowly swallowed. This may be assisted by the external application of ice, in a bladder or ice-bag, to the side of the neck below and behind the angle of the jaw. These measures failing, the bleeding surface should be touched with turpentine, alcohol, or Monsel's solution of iron. If the bleeding proceeds from two or three points, the quickest method of arresting the oozing is with the point of actual cautery. A knitting-needle, in the absence of anything better, can be used for this purpose. Mr. McCarthy, in a case of excision of the tonsils followed by continued bleeding, at the London Hospital, tied the carotid artery with success. The operation of excision has sometimes been done in so reckless and bungling a manner that even the internal carotid artery has been wounded. Velpeau records four cases of this kind. Hæmorrhage from an accident of this nature would require the ligation of the carotid.

In patients who are weak or anæmic, the stump left after amputation of a tonsil will sometimes assume an indolent appearance, the granulations being pale and covered with a layer of gray lymph. A few applications of a crayon of nitrate of silver will soon change the appearance of the granulating surface, converting it into a healthy cicatrizing sore.

Atrophy of the tonsils is so constant an attendant of old age that it might be regarded as a normal and not a morbid condition. After attacks of the severe form of angina, in which the inflammation has been attended with destruction of the connective tissue of the glands, atrophy is not uncommon. The change is of little importance and demands no interference.

Ulceration of the tonsils arises from very diverse causes, as disturbance of the digestive organs, exanthemata, as scarlatina and diphtheria, and constitutional syphilis. When associated with derangement connected with the digestive organs, the ulcers are often multiple, never large or deep, and are covered with a film or patch of lymph. Those which depend on eruptive fevers are often large, deep, irregular sores, with adherent shreds or masses of dead connective tissue, and foul discharges, which charge the breath with a sickening odor. In both varieties of ulcers the other portions of the throat exhibit the signs of inflammation. In the former, however, the color, which is not very red, with the accompanying relaxation of the soft palate and arches, indicates chronicity; while in the latter, the tumid state of the parts, and their livid or dark leaden color, disclose a form of inflammation which is acute, but is at the same time destructive rather than reparative.

Syphilitic ulceration is among the secondary accidents of the disease. The paternity of the sores is betrayed not only by the evidences of the taint in other parts of the body, but also by their being either multiple and with the characteristic sharp, well-defined edges, or solitary, penetrating deeply into

the structure of the tonsil, with ragged margins, steep, abrupt sides, and dark, offensive discharges covering the surface, with a tendency to enlarge and sometimes to become phagedænic.

TREATMENT.—The therapeutical management of these different ulcers must be based on the causes which give them existence. If from indigestion, the treatment will include a very careful regulation of the diet, attention to the secretions, and the use of tonics, both vegetable and mineral, aided by pepsin at each meal. If attendant on certain exanthemata, they must be managed on principles applicable to such diseases; and if arising from syphilis, by the administration of remedies calculated to combat the blood-poison, the most valuable being the iodide of potassium, with the bichloride of mercury.

Abscess of the tonsils has been noticed in connection with tonsillitis. In cases of this kind the suppuration is the result of acute inflammation; but there is another variety of abscess, the existence of which depends on chronic inflammation, and which is developed in a painless manner, and is quite circumscribed, never attaining any great size. This abscess may appear in the course of convalescence from scarlet fever, diphtheria, or smallpox; it may be one of the manifestations of struma, or it may be due to the presence of a foreign body in the gland. When having a scrofulous origin, the glandular elements of the tonsil are involved; when arising from septic or traumatic influences, the disease is located in the connective tissue. Multiple or disseminated abscesses of the tonsils are occasionally among the marked phenomena of pyæmia.

The diagnosis of such an abscess is not difficult. Inspection will disclose a circumscribed swelling, soft and fluctuating to the touch, and having a gray or leaden-colored surface, indicating the true nature of the disease.

TREATMENT.—In ordinary cases it is only necessary to puncture the swelling and give exit to its contents in order to effect a cure. But in those which depend on a strumous state of the system, and in which the pus presents a flaky or cheesy appearance, it may be necessary to touch the interior of the sac with the tincture of iodine or the solid nitrate of silver before securing its obliteration.

Tumors of the Tonsils.

Morbid growths of the tonsils are uncommon. Those which have been observed are the following:

Cystoma.—Cysts have a twofold origin, namely, in the connective tissue, and also in the follicular portion of the gland. When located in the first, the tumor is deep-seated, and will escape observation for a long time. Those which have a follicular history are quite superficial, and are at once visible on inspecting the throat. Such a growth, when central, tends to produce atrophy of the gland, and in one case mentioned by Cohen was the cause of nervous aphonia. A tonsil cyst constitutes a painless, elastic tumor, without any evidences of inflammation. Its contents may be either caseous or ropy.

The treatment will require the cyst to be laid open, and, after turning out its contents, the application to its interior of the compound solution of iodine or solid nitrate of silver. When the cyst is superficial, its entire excision is to be preferred.

Fibroma of the tonsil has its seat in the connective tissue of the gland, and, like similar growths on mucous surfaces, it manifests a disposition to assume the pedunculated form. Tumors of this nature are dense, pale, nearly devoid of sensibility, and require to be clipped off below the mucous membrane.

Lymphoma of the tonsil does not differ either histologically or in regard to treatment from strumous hypertrophy of the gland, which has already been considered.

Carcinoma.—Medullary, epithelial, and scirrhus carcinomata occur in the tonsils, sometimes as primary affections, at other times as secondary to cancer elsewhere. The medullary form of the disease, however, is the most frequent. It is almost invariably limited to the gland of one side, is rapid in its progress, affects males oftener than females, and is rarely seen under twenty years of age. The infiltration extends to the arches, palate, and surrounding parts; the lymph glands under the jaw and in the neck become infected, and as the growth increases it invades finally the mouth, larynx, and pharynx, interfering with articulation, respiration, and deglutition; the patient is at length destroyed either from repeated hemorrhages or from suffocation. The appearance and progress of the disease are so characteristic as scarcely to admit of its being confounded with other growths. The purple color of the tumor, the irregularity of its surface, and the rapidity of its growth reveal but too plainly its malignant character. While I have seen a few cases of both encephaloid and epithelial carcinoma of the tonsil, only once have I witnessed an example of scirrhus, and this in a patient under the care of Dr. Detwiller, of Montgomery County, in this State.

TREATMENT.—An operation can be considered proper only when the disease is strictly limited to the gland, and even then it is of very doubtful propriety. The only possible advantage which can be claimed for surgical interference is the probability of securing for the patient a less terrible death than when the disease is left to follow its natural course. To amount to anything it is necessary that the tonsil be removed in its entirety. This cannot be done without great risk to the internal carotid vessels, even when the enucleation is attempted with the fingers; and for this reason it will be better to adopt the method proposed by Blandin, of removing the gland through the neck from the outside. An operation of this nature will of course require not only accurate anatomical knowledge, but a degree of careful and deliberate dissection which not every one is qualified to undertake. This bold procedure was successfully practiced in one case by Dr. Cheever, of Boston.

Sarcoma of the tonsil is less common than carcinoma. I have seen only two examples of the disease, both consecutive to general lympho-sarcoma, one in a female aged forty-four, and the other in a male about the same age. The tumors in the case of the female were in the groin, axilla, neck, and mammary gland. In both the disease proved fatal. No operation short of the complete extirpation of the gland, when the latter alone is affected, will promise a shadow of relief; and this is so exceedingly uncertain that few surgeons will feel disposed to submit such a proposition to a patient for consideration. The operation, if undertaken, should be done through the neck. Poland* has reported two cases of extirpation by this route, one by Langenbeck and one by Hueter: that by the former is said to have been successful.

DISEASES OF THE SALIVARY GLANDS.

Sublingual Gland.

Sublingual Cysts, Ranula.—The ducts of three different glands open into the mouth beneath the tongue, namely, those of the sublingual and submaxillary glands and of the glands of Rivini. The orifices of these excretory ducts are liable to become obstructed either from mechanical or inflammatory causes. The obstacle thus presented to the escape of the secretion causes the latter to collect, and, by dilating the duct or ducts, to form a tumor beneath the tongue, which is usually termed ranula. It has become common to speak of ranula as a dilatation of the submaxillary duct; but it would be better to discard the term altogether from surgical nomenclature and designate these tumors as retentive cysts, which may arise from the three independent

* British and Foreign Medico-Chirurgical Review, April, 1872, p. 493.

sources already named. Whether the term ranula was given to this affection on account of its color having some resemblance to that of the belly of a frog, or from the peculiar fullness that is sometimes seen to exist below the chin,—another characteristic of this reptile,—it is difficult to determine.

These sublingual cysts are met with chiefly in the young, and are sometimes congenital. They vary in size from that of a cherry up to that of a walnut, have a spherical form, are semi-transparent, and present a gray or bluish color, marked on the surface with branches of the ranine veins; they are unattended with pain. They may eventually, if left alone, attain to such dimensions as to displace the tongue, press their way into the neck, and interfere with the articulation. When one of these cysts attains considerable bulk, it will probably belong to the glands of Rivini, several being included in the disease, and occasioning multilocular ranula. If originating in the sublingual gland, it is not unreasonable to suppose that the obstructed duct or ducts give way, and that the tumor is due to an extravasation of saliva into the connective tissue, the latter becoming condensed, so as to form a limiting wall.

Another variety of sublingual cyst, and one which may form very quickly, is thought by some to consist in an accumulation of fluid in a bursa described as being in connection with the *genio-hyo-glossus* muscle (*supra-hyoid* or bursa of Fleischmann), the fluid collecting in the sac in consequence of rupture of the submaxillary duct from overdistention. This bursa I have never been able to discover.

The contents of sublingual cysts which are connected with the salivary glands are sometimes clear and watery, but oftener they are ropy like the white of an egg, and occasionally I have seen the fluid resemble a mixture of corn-meal and lymph. Dr. J. G. Richardson, of Philadelphia, describes a case in which the fluid contained rice-like bodies; and others have seen a substance similar to fat discharged from the sac.

TREATMENT.—There are three methods of dealing with these sublingual sacs, namely, by partial excision, by the seton, and by injection.

Partial excision is the simplest and most effectual method of cure. The surgeon, raising the prominent portion of the cyst with a pair of rat-toothed forceps, cuts away the front half of the tumor with a pair of scissors curved on the flat, and, after the contents have escaped, swabs the cavity of the sac with the tincture of iodine, or rubs its interior with a stick of nitrate of silver. (Fig. 1663.)

FIG. 1663.



Excision of ranula.

Seton.—This is applied by introducing a needle, armed with a silk thread, through the cyst; and, after tying the ends of the seton together, allowing it to remain until the necessary inflammation has been excited to secure the obliteration of the cyst, which may require six or seven days.

Injection.—The treatment by injection consists in puncturing the sac, and, after discharging its contents, inserting the nozzle of a syringe and depositing eighteen or twenty drops of the tincture of iodine.

There are cases of cyst-like swellings under the tongue which occur suddenly, the *subglossitis* of Ealhouse: these are examples, I believe, of local anasarca, or sublingual dropsy, and demand no surgical

operation, disappearing with the inflammation which produced them.

In two instances I have excised from beneath the jaw large cysts which made very little show in the mouth, and which I am disposed to believe, from their history and contents, were originally due to rupture of the submaxil-

lary duct; and in one case reported by Dr. Garretson, of a similar nature, the probability of such an origin is strengthened by the fact that he discovered, during the removal of the cyst, the fistulous communication between the tumor and the sublingual gland.

Cysts containing some solid material, similar to sebaceous tumors of the scalp, are occasionally met with beneath the tongue, and require that the wall of the cyst shall be dissected out as far as possible, applying to that which remains either nitrate of silver or tincture of iodine. Bryant thinks these encysted tumors are congenital; but I met with one beneath the tongue of a clergyman which had made its appearance only three years before he consulted me.

Carcinoma of the sublingual gland is rarely met with, except when the disease has extended to the gland from adjacent parts. Gross mentions two cases in which the tumor was primary.

Diseases of the Submaxillary Gland.

The submaxillary gland is occasionally the seat of cysts, of carcinoma, sarcoma, enchondroma, and calculi.

Cystic Growths of the submaxillary may arise from a dilatation of some of the tributaries of the duct of Wharton, forming a soft fluctuating tumor beneath the jaw. When the main duct becomes dilated into a cyst, the swelling will appear in the floor of the mouth, or under the tongue, rather than in the neck, in which direction greater resistance would be encountered. Many of these so-called submaxillary cysts, however, are cystic degenerations of the lymph gland, which rests on the former. I have frequently removed such growths and found the salivary gland intact beneath.

A cyst situated in or about the submaxillary gland may be determined by the boundaries of the tumor. No region is so perfectly defined by structural boundaries as the submaxillary. Hence, when the tumor does not extend posteriorly behind the angle of the jaw, or inferiorly below the great horn of the hyoid bone, and when anteriorly it is outlined by the crescentic sweep of the digastric muscle, its limitation to the submaxillary region may be confidently affirmed.

Excision is the proper remedy for such cysts.

Enchondroma is sometimes met with in the submaxillary gland, forming a hard, knotty, or lobulated tumor, which grows in a slow and painless manner and is firmly imbedded in position. These growths are made up of masses of different kinds of cartilage, with intermediate strata of connective tissue, and sometimes undergo partial calcification or ossification. They will require to be removed by excision.

Adeno-Sarcoma.—Neoplasms of this character are at first very deceptive. They begin much in the same manner as an adenoma of the gland. The growth is steady, uniform in all directions, and painless, with no tendency to discoloration, ulceration, or attachment to the skin. Tumors of this kind require to be removed by the knife, but are likely to return. In one which I excised, the growth did not reappear until eight months after the operation.

Carcinoma.—The submaxillary gland becomes the seat of cancer, both primary and secondary. Primary cancer of the gland is generally of a scirrhus nature, and occurs in adults. The leading characteristics of a tumor of this nature are extreme hardness, irregularity of surface, immobility, and darting pains. It grows rapidly, acquiring considerable bulk; the skin becomes discolored, adherent, and ulcerates, and if the tumor develops

towards the floor of the mouth it will displace the tongue and embarrass articulation, mastication, and deglutition. The lymphatic glands of the neck contiguous to the submaxillary become infected and enlarged. Secondary carcinoma of the gland is induced by an extension of the disease from parts which are adjacent, as in cancer of the tongue or of the jaw.

DIAGNOSIS.—The affections with which it is possible to confound carcinoma of the submaxillary gland are cysts, lymphoma, sarco-lymphoma, and enchondroma.

The smooth, soft, elastic, and fluctuating properties of the cystic tumor are in such striking contrast with the irregular, hard, and unyielding surface of scirrhus as scarcely to admit of error. Lymphatic tumors are generally met with in young persons, are movable, firm, but not hard, show no tendency to become adherent to the skin, not unfrequently break down and suppurate, and do not contaminate the general system.

The points of distinction between scirrhus and sarcoma are the elastic feel, uniform smoothness of surface, absence of pain, discoloration of the overlying skin, and absence of tendency to ulceration which characterize the latter, cancer presenting in each instance the reverse condition.

Enchondromata greatly exceed in hardness and irregularity of surface scirrhus tumors, nor do they tend to ulceration, discoloration of skin, or the production of a cachexia like the latter. They are also comparatively free from pain, and quite slow in their growth.

Calculi.—Calculus concretions are frequently discovered in the submaxillary. They are usually somewhat cylindrical or elongated, and are composed of phosphate and carbonate of lime, held together by some organic matters derived from the salivary secretion. They sometimes attain considerable size, and, by filling up and distending the duct, give rise to cystic accumulations. The presence of a body of this nature can be discovered, when it is not visible beneath the mucous membrane of the mouth, by pressing the floor of the latter on the affected side between the two fingers, one on the inside of the oral cavity and the other beneath the jaw. In all cases of sublingual cysts an examination for salivary calculus should be instituted.

These concretions are sometimes found at the commencement of the submaxillary duct before it leaves the gland, or even in the radicles of the duct, in the midst of the gland-tissue, causing a diffuse suppuration of the submaxillary.

TREATMENT.—The calculus is to be removed by making an incision through the wall of the attenuated duct, and scooping the concretion out, either with the finger-nail or with the concave end of a director, or by dragging it away with the forceps.

Removal of the submaxillary gland.—The patient being placed on a table, with the shoulders raised, and the head well thrown back, and turned to the side opposite to the one affected, a crescentic incision in the cavity below is made over the affected gland through the integument, extending from the angle of the jaw to the base of the bone, about one inch short of the symphysis.

The platysma myoides and deep fascia are next to be raised on a director and divided, when the gland, or any tumor occupying the same region, will be exposed. After incising or breaking up a layer of connective tissue which fastens the gland to the tendon of the digastric and the great horn of the hyoid bone, the submaxillary can easily be separated with the finger from its connections with the hyo-glossus and mylo-hyoid muscles beneath, and turned over upon the face. Before entirely dislodging it, the facial artery, which enters the gland at its inner and lower border, will require ligation, after which, dragging the mass from its bed with a vulsellum, and putting its deep attachments on the stretch, they can be severed, and the submaxillary removed without injury to the hypoglossal nerve, which lies between the gland and the hyo-glossus muscle.

Diseases of the Parotid Gland.

The affections of the parotid gland which often call for surgical interference are parotitis, abscess, salivary fistula, salivary calculus, and morbid growths.

Parotitis, or Mumps, is an inflammation of the parenchyma of the parotid gland, and of an infectious nature. It is a disease almost exclusively confined to the young, though occasionally seen in persons in middle life. It is more common in the winter and spring months, and one attack generally secures an exemption from a second.

SYMPTOMS.—The attack of parotitis is ushered in by a sense of soreness and stiffness of the jaws, and a swelling in front of the ears, extending down to the angle of the jaw, very sensitive to the touch or to any movements of the maxilla. As the disease advances, deglutition becomes painful, and there is frequently some degree of febrile excitement. The acme of the inflammation is reached on the fourth day, after which the disease gradually declines, and in six or seven more days entirely disappears.

The inflammation in parotitis has a singular and wholly inexplicable tendency to recede suddenly from the affected gland and to attack the testis or the mammary gland. This may occur not only during the active stage, but even when the disease is on the decline.

Aggravated cases of parotitis, particularly if the system has been weakened by previous disease, are liable to terminate in abscess; and the same result occasionally occurs as a sequel of low forms of certain exanthemata, as scarlatina and smallpox, typhoid fever, or erysipelas. Even gangrene may follow after such antecedents.

TREATMENT.—Parotitis, having a specific course to run, rarely demands any other treatment than rest, confinement to the room or bed, a gentle aperient, a liquid diet, and warm lotions of laudanum and water, or a hot solution of muriate of ammonia and laudanum.

The induration due to the inflammatory infiltration of the gland, which often remains after the acute symptoms have passed away, will generally disappear without special treatment; but should it prove tardy in this respect the process may be hastened by stimulating frictions with soap liniment containing a little iodide of potassium and oil of amber, or by painting over the gland with the compound solution of iodine.

When the disease is translated to the testicle, an attempt should be made to re-establish the inflammation in the gland by applying a blister over its surface. If this proves unsuccessful, the case must be treated as one of orchitis, by leeches along the course of the cord, followed by vesication, produced by drawing a stick of nitrate of silver longitudinally over the scrotum at three or four places, and by the internal administration of the iodide of potassium and the bichloride of mercury.

Abscess of the parotid is indicated by a swelling defined by the boundaries of the gland, a dusky discoloration, and œdema of the overlying integument. The suppuration is attended with great pain, rigidity of the jaws, rigors, and other signs of much constitutional disturbance. If not early recognized, and if allowed to go unrelieved, the swelling will extend over the entire side of the face, and even to the eyelids. These abscesses are diffused, not circumscribed; the pus finds its way through the cartilage into the ear, or travels into the neck, causing extensive and in some instances fatal disorganization of the tissue, and pyæmia.

TREATMENT.—As soon as the existence of pus is detected, an incision must be made through the skin and the superficial and deep fascia, dividing the last two layers on the director, in order that the gland-tissue proper shall not be opened,—an accident which is liable to be followed by a salivary fistula, which is often difficult to close. The incision, when feasible, should be

near the lower part of the gland, thus favoring by its dependent position the drainage of the abscess. After the parotid has been exposed, should the pus not flow, the interlobular connective tissue will require to be broken away by the end of a director at the softest part of the gland until the collection is reached, when the opening must be kept pervious by the introduction of a drainage-tube until the suppuration ceases. It will be necessary, after the opening has been made, to apply over the parts hot flaxseed-meal poultices for a few days, until the tissues have become unloaded and contracted. When from delay the pus has found its way into the neck, it is equally important, in addition to opening a way into the gland, to reach the collection in the neck, first by the formal division of the skin, superficial fascia, platysma myoides muscle, and deep fascia, and afterwards by conducting the dissection with the end of a probe. The constitutional disturbance attending a parotid abscess is of a character to demand tonics, stimulants, and the best food.

Salivary Calculus.—Concretions of this kind are sometimes formed in the duct of Steno, and are of the same chemical composition as those met with in the duct of Wharton or in the sublingual ducts. They are cylindrical in form, and lie parallel with the long diameter of the duct.

FIG. 1664.



Salivary calculus taken from the duct of Steno.

In one case the calculus measured an inch and a half in length (Fig. 1664), and formed a very prominent ridge on the outside of the face.

A concretion of this nature will obstruct the passage of the saliva into the mouth, causing the gland to swell from the retained secretion, and may be detected by pressing the cheek between the fingers, placed one on the inside and the

other on the outside, in the line of the duct. If allowed to remain, ulceration of the cheek may follow, and as a consequence a salivary fistula.

TREATMENT.—The calculus should be removed from the inside of the mouth by opening the duct and extracting the concretion with the finger, scoop, or forceps.

Salivary Fistula of the parotid duct has been discussed in connection with wounds of the face. (See vol. i. page 313.)

Nervous Enlargement of the parotid is a rare affection. I had under my care during the winter of 1879 a very marked case of this kind in a lady of a highly-emotional temperament. When the attacks came on, they were generally preceded by some mental excitement. Both glands in a few minutes would enlarge, and a sense of fullness would be experienced in the neck, accompanied with a constant desire to swallow.

Emotional causes act in producing increased secretion of saliva and give rise to the swelling of the glands in a different manner from those reflex impressions which are transmitted through the lingual and chorda tympani nerves under the excitation of food. Their effect must be explained by a consideration of the communications between the sympathetic and excito-secretory branches of the gland.

The treatment in emotional enlargement of the parotid must be chiefly moral, with the assistance of antispasmodics, the best of the class being either bromide of potassium or assafœtida.

Tumors.

The morbid growths which find a habitat in the parotid gland are cystoma, fibroma, enchondroma, sarcoma, adenoma, carcinoma, myxoma, and lipoma.

The gland is also remarkable for the compound character of its neoplasms, many of these possessing the histological elements of both myxoma and

fibroma, of myxoma and enchondroma, of myxoma and carcinoma, of cystoma and sarcoma, and of lipoma and sarcoma.

It is exceedingly difficult, in a soil so fruitful in producing these multitudinous and complex growths, to attempt a nice clinical differentiation or classification.

As a practical clue in threading this labyrinth, some general rules may be formulated.

If we assume that the time allotted to morbid growths of the parotid rarely extends beyond the fiftieth year of life, and if we divide this into three periods, namely, one between eighteen and twenty, one between twenty and thirty-five, and one between thirty-five and fifty, it will be found that in most instances those growths which occur within the limits of the first period are myxoma, enchondroma, carcinoma, particularly of the soft variety, and cystoma; those which appear in the course of the second period are sarcoma and fibroma; and those which arise within the third period are carcinoma, of the scirrhous and epithelial varieties, and lipoma-sarcoma.

A very important differential sign between those tumors of the parotid which are malignant and those which are benign is the tendency in the former to infect the lymph glands.

Again, some approximate idea of the nature of parotid tumors can be obtained by considerations of growth, character of surface, density, mobility, and pain. Those which grow most rapidly are the encephaloid variety of carcinoma and sarcoma. The skin over the former growths soon becomes purple and adherent to the surface, ulceration following at one or more points, and through the opening protrude masses of fungoid granulations, which furnish an unhealthy ichorous discharge having a very offensive smell. Encephaloid growths have a soft and elastic feel, and soon poison the neighboring glands.

Sarcomata, while they frequently increase quite rapidly in size, do not grow with the speed of encephaloid disease. They have a doughy rather than an elastic feel, and the skin, notwithstanding that it becomes stretched and attenuated by the growth of the tumors, exhibits little tendency either to discoloration or to adhesion to the surface of the growths. Those tumors which progress more slowly are enchondroma, fibroma, cystoma, and scirrhous. Except the last, these growths are all movable in their early history, becoming more fixed, and even immovable, as they increase in size.

Enchondroma, in consequence of its extreme hardness and its knobby or irregular surface, can usually be differentiated from the others. Fibrous tumors, though very firm in their consistence, are less so than the cartilaginous, besides possessing a more uniform exterior.

The elasticity of cysts, partaking somewhat of the character of fluctuation, will furnish an important diagnostic sign; while the small, dense, inelastic, fixed, tardily-growing scirrhous, with its accompanying shooting pains, can scarcely be mistaken for any other disease.

THE ACCESSORY PAROTID.—This is the name given to a number of lobules which lie beneath the zygoma and are in great measure detached from the main mass of the gland. This part of the parotid, though less liable than the main gland to become the seat of disease, is by no means exempt.

All neoplasms in this situation, which in their histological elements are composed either exclusively or in part of gland-tissue, are by many writers believed to commence in this accessory parotid.

Tumors over the Parotid.

Lymphoma.—In the loose connective tissue which covers the parotid fascia lie a number of lymphatic glands, which are frequently the subject of morbid changes, especially of a strumous or tubercular character. The same bodies may undergo cystic, enchondromatous, or sarcomatous degeneration, giving

rise to tumors of their different classes, each of which presents the characteristics of the neoplasm to which it belongs.

Fibrous Tumors also arise in the connective tissue covering the parotid gland, and frequently acquire considerable size. Whatever may be the character of these tumors, they tend after a time to cause the absorption of the parotid fascia, and finally to imbed themselves in the substance of the parotid, or even to cause by pressure its entire destruction, the new formation occupying the original seat of the gland.

To distinguish between parotid and supra-parotid tumors is by no means difficult. The former, even when most benign, never admit of much mobility, while the reverse is true in regard to the latter. Even when a superficial growth has gradually destroyed the parotid and taken its place, and has become more fixed, inquiry will bring out the fact that it was freely movable at an earlier period.

Another important topographical difference exists between parotid and supra-parotid tumors. Those which are seated primarily in the parotid gland are, during a considerable period of their history, confined strictly within certain boundaries, namely—above, the zygoma; below, a line extending from the angle of the jaw towards the mastoid process of the temporal bone; posteriorly, the temporal bone and the cartilage of the ear; anteriorly, the posterior border of the masseter muscle and the angle of the jaw; while those which are seated over the parotid region, when they acquire considerable bulk, have no such sharp definition,

but extend in the direction of least resistance, or rise from a narrow base. (Fig. 1665.)

TREATMENT.—Extirpation of the parotid gland is perhaps the most difficult operation in surgery. Professor Gibson, even until the time of his death, stoutly maintained that the operation was impossible. Viewing the subject from the standpoint of normal anatomy, such an opinion is quite tenable; but when the changes produced by disease are considered, a different conclusion will be reached, as under the influence of the latter the components of the gland (especially in fibroma, enchondroma, and scirrhus) are firmly bound together, and admit of the gland or tumor being dragged out of the irregularities of the region, in its totality, without breaking up into fragments. In encephaloid and sarcoma, if once the capsule of the gland has given way,



FIG. 1665.

Fibrous tumor over parotid gland.

and the disease passed beyond its limits, the task of extirpation is as difficult as it is hopeless.

There are not less than 108 cases recorded in which the evidence of the entire gland having been removed scarcely admits of a doubt.

Surgical anatomy.—The parotid space is a deep fissure, bounded in front by the posterior margin of the ramus of the inferior maxillary bone, behind by the auditory canal and the mastoid process of the temporal bone, above by the zygomatic arch, and below by a line extended horizontally back from the angle of the jaw to the sterno-cleido-mastoid muscle. The region is broadest below, gradually contracting into a fissure above.

The stylo-maxillary fascia completely isolates the parotid from the sub-maxillary region. The deep surface below is formed by the styloid process and the bouquet of Riolan, or that radiation of muscles and ligaments which takes place from the process. The parotid, which fills up the space thus defined, is tunneled by the external carotid, which as it emerges from the gland above divides into the temporal and internal maxillary arteries. It is traversed by the cervical, facial, and temporal branches of the facial or

portio dura nerve, also in an upward direction by the temporal branch of the inferior maxillary nerve, and below by the temporo-parotid vein, the chief tributary of the external jugular. At the posterior border of the gland, between the latter and the mastoid process of the temporal bone, pass out the posterior auricular artery, the auricular branches of the superficial cervical plexus, and the facial nerve. Immediately beneath the floor of the parotid space lie the internal carotid and the internal jugular vein, also the spinal accessory, glosso-pharyngeal, and pneumogastric nerves, and a small portion of the hypoglossal. The lymph glands which rest on the parotid fascia form a continuous chain with those of the neck.

It will be apparent from the general outline of the components of the parotid and of the adjacent regions that the removal of the gland is an operation which involves accurate anatomical ideas guiding a cool, deliberate dissection, and is never to be rashly undertaken. The rule laid down by Sir William Fergusson for the removal of parotid tumors is based on their mobility. If immovable, extirpation should not be attempted. I would restrict extirpation to benign growths. An operation for the removal of those which are malignant is powerless to prevent a recurrence of the malady, and materially shortens life.

OPERATION.—I have twice removed the gland entire, and in describing its excision I shall confine myself to the plan adopted in both operations.

The patient should be placed upon a table, with the shoulders elevated, and the head turned to the opposite side from the one affected. An incision is next carried from the zygoma, over the middle of the tumor, down to a point a short distance below a line drawn from the angle of the jaw, horizontally across the neck, to the sterno-mastoid muscle. In very large tumors it may be necessary to add to this another incision at right angles with the first, or to make two elliptical cuts. The integument is next dissected from the growth, anteriorly and posteriorly, turning the flaps over the face and the ear, making as ample an exposure of the growth as possible. Any vessels which bleed freely during this stage of the operation must be tied, or secured with artery forceps. Next let the dissection be carefully made at the lower or cervical extremity of the tumor, until that portion of the growth can be detached, when it should be drawn outward and upward by a vulsellum. In doing this, the external carotid artery will be raised from its bed, and, after being isolated from any adherent shreds of connective tissue, must be tied at two places and divided between. By drawing the tumor well forward, and keeping the edge of the knife, or the handle of the same, close against its surface, the auricular nerve and the branches of the superficial cervical plexus can be avoided. The finger may at this stage do the work of the knife, and should always be preferred to the latter as the safer instrument, so long as the deep attachments of the tumor yield to its pressure, aided by simultaneous traction. In dislodging the gland from its bed, the portio dura nerve, if the tumor is one primarily implicating the gland, must necessarily be divided. Directions which are sometimes given with reference to avoiding this nerve in the extirpation of the parotid are practically useless, unless the substance of the growth is very soft or friable, when the cervical branch, with the main cord of the nerve, may be separated by the careful use of a director, and the facial paralysis thereby lessened in extent.

Of greater importance, however, is the safety of the internal carotid artery and jugular vein, together with the nerves which lie in their company. These, being immediately beneath the parotid region, are necessarily in dangerous propinquity, and might easily be dragged from their own into the region under consideration, and thus be exposed to injury. Indeed, the jugular vein is frequently obliterated by the pressure of the tumor. Every strip of tissue, therefore, which continues to fasten the parotid tumor down in this locality must receive a most careful inspection with the eye before being divided.

The upper portion of the gland is the last extirpated, and the operation here necessarily involves the division of the internal maxillary and temporal arteries. As these vessels have an extensive range of anastomoses, it is well to place a ligature around the trunk of each, and thus diminish the risks of subsequent hemorrhage. After the extirpation is completed, the flaps are to be replaced, united by sutures, and supported with a compress of lint moistened with carbolated oil, and covered with a pad of oakum, both being secured by vertico-maxillary turns of a roller.

In removing tumors which are situated over the parotid, the most important object to keep in view is the separation of the growth from the gland beneath without opening any of the lobules, an accident which is likely to be followed by a salivary fistula. For this reason, enucleation should take precedence of dissection with the edge of the knife whenever possible.

The extirpation of the parotid gland was first performed in America by Warren, of Boston, in 1798. This operation pioneered the way for those of McClellan, of Greencastle, Franklin County, Pennsylvania, in 1805, of White, of Hudson, New York, in 1808, and of Sweat, of Maine, the last-named surgeon having repeated the extirpation three times between the years 1811 and 1841. It was not until 1826 that Dr. George McClellan, of Philadelphia, whose name is more prominently associated with this operation than that of any other surgeon, made his first excision of the parotid. The patient was a medical student, on whom a previous but unsuccessful attempt had been made in Dublin to extirpate the gland. The case, though attended with considerable difficulty and hazard to life, was brought to a successful termination, the individual making a permanent recovery.

The operation of tying the carotid has been adopted in a few cases of parotid tumors, where extirpation was not deemed advisable, with a view to induce atrophy of the growth by cutting off the supply of blood. The method is said to have been successful in two or three instances in the hands of Hossack, of New York; but the facility with which the blood, through the collateral vessels, again reaches the gland, renders the practice scarcely worthy of imitation, if undertaken on the principle of starvation.

Wounds of the duct of Steno have been discussed under the head of *Injuries of the Face*, vol. i. p. 313.

Affections of the Pharynx and Œsophagus.

GENERAL CONSIDERATIONS.—In order to examine the pharynx, the only instrument ordinarily required is a tongue-depressor (Fig. 1666), in the absence of which a spatula or the handle of a large spoon will answer every purpose. The patient should be placed before a good light and directed to open the mouth, when the dorsum of the tongue is to be depressed with the instrument.

In many persons the reflex sensibility of the fauces and pharynx is so great that the simple contact of the instrument with

FIG. 1666.



Tongue-depressor.

FIG. 1667.



Pharyngoscopic mirror.

the tongue is sufficient to excite violent muscular contraction in these muscles and defeat the object in view. With such patients a very good view of the parts can be obtained by requesting them, after opening the mouth,

either with or without the protrusion of the tongue, to take a strong inspiration. A pharyngoscopic mirror (Fig. 1667) will sometimes be found useful in obtaining an image of recesses of the pharynx which otherwise could not be fairly explored by the unassisted eye.

As mucus is often found adhering to portions of its surface, a delicate metallic scraper or curette (Fig. 1668) will prove useful in removing such accumulations.

FIG. 1668.



Scraper.

Congenital defects.—Malformations of this nature possess little interest for the surgeon, as they are generally incurable or associated with other imperfections which are fatal to the life of the child. Thus, the pharynx may terminate in a cul-de-sac behind the larynx, the œsophagus being absent, or it may open on the surface of the neck.

Neuroses of the Pharynx.

Disorders of sensation or of motion are frequently observed in this part of the alimentary tube.

Disorders of Sensation.

Anæsthesia.—The most remarkable instances of diminished pharyngeal sensation are witnessed among the insane; and the diminution of sensation accounts for their ability to introduce into the alimentary passages divers materials of great size and irregularity of surface. Certain diseases, as diphtheria and paralysis, have the effect of lowering the sensibility of these parts. Anæsthetics induce a like condition, though in a different way.

Hyperæsthesia is often due to a natural exalted state of reflex irritability, and can frequently be greatly lessened by familiarizing the parts with the contact of instruments. Among the common causes of hyperæsthesia from morbid conditions are elongation of the uvula, tonsillitis, catarrhal pharyngitis, laryngeal phthisis, disease of the cervical vertebræ, and the lodgment of foreign substances in some of the loose folds about the arches or the root of the tongue. Pharyngeal irritability is common among smokers, in consequence of the follicular disorder induced by tobacco.

The normal irritability of the pharynx has a certain value, of which advantage may sometimes be taken. Thus, in croup, with large accumulations of laryngeal and tracheal mucus, and when the depressing effects of emetics are to be avoided, the titillation of the fauces and pharynx with a feather or the finger will induce those muscular contractions which are sufficient to effect expulsion.

In the same manner a stomach overloaded with crude and indigestible ingesta, threatening cerebral trouble or colic, can be relieved of its contents, or quick emesis can be promoted when poisonous substances have been accidentally swallowed.

The hyperæsthesia sometimes becomes so great that nothing whatever can be swallowed without provoking *spasm*.

As hyperæsthesia, when it assumes the importance of a disease, is often secondary to morbid conditions in the adjacent parts, it will be necessary to seek for these, and, as far as possible, remove them. Whatever may be their character, whether resulting from inflammatory changes, from the presence

of foreign bodies, or from hurtful habits, the irritability will be lessened by the internal use of the bromide of potassium, and by painting the pharynx once daily with a solution of nitrate of silver or tincture of aconite. When spasm exists, precluding alimentation by the mouth, the patient can be nourished by nutritious enemata.

Perverted sensations are almost peculiar to women, and frequently owe their existence to a hysteroidal state, though the latter may have a real physical basis, as is often seen in uterine disorder or while a woman is passing through the perturbation of the menopause. Under the head of perverted pharyngeal sensibility come cases of foreign bodies in the throat which have no existence except in the imagination of the patient. I have known the idea of a fish- or chicken-bone to harass a nervous individual for months; and in one instance the medical attendant was so far deceived by the representations of the patient as to have denuded in mistake the great horn of the hyoid bone in ineffectual attempts to drag away what was supposed to be a foreign body fastened in the wall of the pharynx. An ever-present fruitless hawking or coughing is also among the nervous disturbances of this part of the gullet.

It is never proper, however, to dismiss these cases without a careful examination, so as to exclude the possibility of error, and when satisfied that these sensations have no foundation in fact, then attention must be given to the general health, and to the removal of any detectable cause to which their existence might be referred, together with the use of the bromides and other antispasmodics. I have known the physician intentionally to fall in with the delusion, and by a little professional sleight of hand endeavor to lead the patient to believe that the material cause of the local trouble had been removed, but never with success: indeed, I have no faith in either the therapeutics or the morality of professional deception. Nor is the method sometimes resorted to, of ridiculing and badgering the patient with regard to an infirmity, to be commended. More will be gained by honestly informing the subject of the sensations that they are real, but that they proceed from causes different from those supposed.

Disorders of Motion.

The muscles of the pharynx are subject to different disorders affecting their mobility, some of which are hysterical, while others are central.

Nervous Dysphagia is generally met with in females and those whose health has been damaged by exhausting disease. The chief characteristic of the muscular disorder is an inability to swallow food, especially solids, particularly when in the presence of others. It does not necessarily indicate any organic disease, but it is occasionally among the first symptoms of stricture of the œsophagus, even before the structural changes are sufficient to offer any sensible mechanical impediment to the passage of food. When not due to organic disease, the remedies for its relief are those which aid in restoring the general strength and vigor of the body, as tonics, antispasmodics, concentrated nourishment, and a life in the open air.

Chorea of the pharyngeal muscles, due to a loss in the inhibitive or co-ordinating government of this portion of the apparatus of deglutition, will sometimes occur. There is not in these cases the timidity or irresoluteness of will in swallowing that belongs to pure nervous dysphagia. On the contrary, persons who labor under this affection, and who are usually young females, make repeated and persistent efforts at deglutition; they will deliberate, and choose a seemingly opportune moment to endeavor to transmit the bolus of food to the œsophagus. The disability will yield to iron, arsenic, and the shower-bath.

Paralysis of the muscles of the fauces and pharynx is a common attendant

on diphtheria, and one which will frequently remain long after all other manifestations of the disease have disappeared. In attempting to swallow fluids, they are found to pass into the nose, partly because the velum, participating in the paresis, is unable to shut off the post-nasal from the post-faucial space of the pharynx. The gradual loss of power in the pharyngeal muscles of deglutition is also a prominent symptom in bulbar paralysis; it commences in the tongue, advances a little later to the lips, and at length reaches the palate and pharynx.

This disease is rarely encountered under thirty years of age. The involvement of the oral as well as of the faucial and pharyngeal muscles affects not only deglutition, but also articulation, phonation, and salivation, the saliva constantly dribbling from the mouth. Pharyngeal paresis may arise from syphilitic disease, and is then calculated to create the greatest anxiety, depending as it does on central changes, which may suddenly terminate life in a convulsion.

Unilateral loss of pharyngeal power may also attend paralysis of the face.

Diphtheritic paralysis is removed only by time, aided by the use of iron tonics, food, and good air.

Bulbar paralysis, originating as it does in sclerosis and other degenerations in the gray matter of the medulla oblongata and upper end of the cord, is incurable.

Syphilitic paralysis demands the prompt administration of large doses of the iodide of potassium with mercurial inunction.

The loss of power which attends faucial paralysis will be recovered in case the latter improves. The remedies which aid in bringing about this result are the iodide of potassium, with or without alterative doses of mercury, in the early stage of the affection, and later strychnia, with the cautious use of electricity.

Neuralgia of the pharynx is described by some writers. The symptoms are pain, generally unilateral, sometimes dull, at other times acute, accompanied by a sense of constriction, and with occasional muscular spasm. The subjects of the affection are usually young girls, anæmic and out of health; but women of mature years laboring under uterine disorders are also affected.

While I have frequently seen patients who complained of anomalous and painful sensations in the throat, I have never thought that the attacks, which were not severe and were without any periodical or paroxysmal feature, were entitled to the name of neuralgia. These cases were, moreover, relieved by antispasmodics, particularly the bromide of potassium, which confirmed me in the opinion of their being nervous rather than neuralgic.

The treatment in a case of pharyngeal neuralgia, should such occur, would be the same as when the disease fixes on other regions of the body, namely, quinine, arsenic, iron, and piperine.

Inflammatory Affections of the Pharynx.

Inflammation of the pharynx occurs from both common and specific causes. Pharyngitis from common causes, as cold and sudden alterations in temperature, is popularly known as sore throat, and is usually an inflammation which includes the fauces as well as the pharynx.

A little dryness and stiffness of the throat, followed by a feeling of soreness, which renders deglutition uncomfortable, and the abundant formation of tenacious mucus, preceded in some cases by a sense of chilliness, are the symptomatic phenomena which characterize the disease. The inflammation subsides ordinarily in a few days, requiring nothing more than confinement to the house. A gentle aperient, followed by a few doses of neutral mixture, is generally all that is required in the way of medicine. If the throat continues to remain sore, a gargle of chlorate of potash or the application of a weak solution of nitrate of silver will afford relief.

Atrophic Pharyngitis.—Repeated catarrhal attacks, particularly in persons somewhat advanced in life, are calculated to degenerate into a chronic inflammation of the pharynx, and, being attended by the gradual disappearance of the submucous connective tissue, have been called atrophic pharyngitis. The mucous membrane will be seen to be dry, red, and polished or glazed, without any appearance of secretion. The patient complains of dryness of the throat and soreness after talking or in swallowing.

The disease admits only of palliation, which is obtained by the use of cubebs, both internally and topically. The remedy is most conveniently administered in the form of the fluid extract, given with a little syrup of Tolu and wild cherry. The local application is best made by inhalation, pouring for this purpose some boiling water over powdered cubebs placed in a tin vessel, and drawing the vapor into the throat through the neck of a funnel reversed and placed over the cup. A lozenge composed of muriate of ammonia and extract of liquorice allowed to dissolve slowly in the mouth, at the same time swallowing the saliva, will also conduce to the comfort of the patient. As such persons often sleep with the mouth open during the night, thus increasing the dryness by evaporation, Cohen has advised the use of a bandage with which to secure together the jaws.

Follicular Pharyngitis, sometimes called granular sore throat, is an exceedingly common affection in the United States. Writers recognize two forms of the disease, the *hypertrophic* and the *exudative*.

It begins as an ordinary pharyngitis or tonsillitis, which, from repetition, neglect, failing health, or pulmonary disease, merges into a chronic form of inflammation, which at length extends from the surface into the follicular portion of the mucous membrane, and causes, by infiltration, thickening or hypertrophy of the glandular elements of the mucous membrane.

In the commencement of the disease the hypertrophied glands appear as small points, less than a pin's head in size, and scattered over the posterior wall of the pharynx, but in the advanced stage of the affection they increase in number and size, until many coalesce, forming numerous elevations or ridges of the mucous membrane, separated by depressions occupied by dilated veins. The granulations are often covered with tenacious mucus. In the exudative variety, the follicles become surcharged with the perverted secretion, which, by being retained, assumes a cheesy appearance. These structural alterations are not restricted to the posterior wall of the pharynx, but ultimately, if not early subjected to treatment, extend to the post-nasal and inferior parts of the pharynx, and also to the fauces. Notwithstanding the fullness of the veins which is observed in aggravated or protracted cases of granular pharyngitis, imparting a blue shading to the mucous membrane, the vascularity of the glands is not increased; indeed, some think it is less than normal. The cheesy contents of the follicles consist of disintegrated epithelial cells, and sometimes contain hard, white, gritty particles, due to the presence of lime-salts.

Follicular disease of the throat is thought to be quite peculiar to clergymen, and is often attributed to the flexed position in which the head is held during preaching, rendered necessary by the habit of delivering sermons from the manuscript. It is true that when the head is bent towards the breast the walls of the pharynx are relaxed, and consequently their vessels are less perfectly supported than when the head is erect during speaking, and the explanation is not without some plausibility. But I am of opinion that, disconnected with the confinement of the study, with faulty digestion, and with the wretched habit of standing uncovered in cemeteries and graveyards during inclement weather, while dispensing the last duties to the dead, service at the sacred desk would play an insignificant part in the causation of throat disease. Indeed, I do not believe that clergymen as a class, or as compared with members of other professions or callings, are in any way peculiarly subject to granular pharyngitis.

TREATMENT.—Both local and constitutional treatment are required for the removal of follicular disease of the pharynx, modified according to the form of the affection. In the first or hypertrophic variety, any error of diet which can be discovered, and which is calculated to disturb the digestion, should be corrected, and the bowels, if constipated, regulated by gentle aperients. Public speaking, if a part of the patient's duty, must also be discontinued for a time; after which local applications must be addressed to the mucous membrane, in order to secure the reduction of the thickened glands. For this purpose resort may be had to one of four remedies, namely, iodoform, the compound solution of iodine, nitrate of silver, or tincture of the chloride of iron. The first is applied by adding two grains of iodoform to half an ounce of glycerin, and brushing the mixture over the wall of the pharynx daily. The compound solution can be used in the same way, but should be rendered less irritating, before being applied, by adding to each ounce of the solution one drachm of laudanum and thirty grains of pulverized gum acacia. The nitrate of silver, when employed, may be prepared in the strength of thirty grains to the ounce of distilled water. The tincture of the chloride of iron may be brushed on in full strength.

With these remedies, especially when the general health of the patient is impaired, the internal use of a pill composed of iodoform, iron, and quinia after each meal will contribute to recovery, to which may be added, when circumstances allow, change of air. When the granulations show no disposition to yield to the above treatment, they must be attacked by destructive cauterization.

There are two agents employed for this purpose, namely, equal parts of chloride of zinc and quick-lime, or caustic soda and quick-lime. The last is the least painful and the most manageable. In England it passes under the name of the London paste. In using the caustic, a sufficient amount of water is added to the powder to form a thin paste, a small portion of which is to be applied on the point of a pin to one or two of the granulations for four or five seconds, when the patient should wash away the redundant caustic by gargling the throat with water.

This process can be repeated every four or five days to other follicles until all have been destroyed. In the exudative form of the disease it will suffice to clear away from the surface of the mucous membrane the adherent secretions, and after pressing out from the follicles, with the finger or the edge of a spatula, any accumulation which may be present, to touch each with a crayon of sulphate of copper or nitrate of silver.

Diphtheritic Pharyngitis is a form of inflammation accompanied by a deposition of lymph, either in patches or in the form of a membrane, not only over the mucous membrane of the pharynx, but also upon the fauces, larynx, and adjacent parts. The disease depends on the presence in the blood of some subtle organic poison, probably of vegetable origin, generated under bad hygienic conditions, and rendered active by atmospheric peculiarities of construction.

The adynamic tendency of the disease is very marked. Diphtheria is by many regarded as a variety of croup, of which I shall have occasion to speak when considering affections of the air-passages. Children between one and five years of age are chiefly the subjects of diphtheria. The disease, in addition to attacking the pharyngeal, laryngeal, and nasal mucous membranes, tends to implicate the kidneys, and to induce local and even general paralysis. The false membrane consists in a fibrinous infiltrate, situated in the upper layers of the mucous membrane of the throat, having an ashy, sometimes a yellowish, appearance, and when separated from the surface of the pharynx or fauces leaves the mucous membrane red and glazed.

TREATMENT.—As the local disease is only the visible manifestation of the constitutional infection, remedies applied only to the throat exercise very little, if any, control over the disease.

The first duty of the physician in commencing the treatment of diphtheria is to ascertain whether the disease depends for its existence on local or on general causes. When several children in the same house, or in the same locality, alone suffer, while others adjacent are exempt from the affection, it will be strong presumption in favor of the former, when the evil should be traced to its source, and corrected as far as possible, or the patient removed beyond its malign influence. If, on the contrary, the disease is wide-spread, affecting a large district of country or an entire town, its general or epidemic character will be apparent.

The constitutional treatment which in my own experience has been found most beneficial is the bold administration of chlorate of potash, tincture of iron, and capsicum, with milk-punch and beef-essence as nourishment. Among internal remedies, salicylin, or the salicylate of soda, has been extolled especially by Hanou, of Erlangen, though others regard the remedy as of little value. Similar differences of opinion exist in regard to the use of carbolic acid. The local applications in use are tincture of chloride of iron, nitrate of silver, diluted carbolic acid, the steam from slacked lime, alum, tannin, and many others.

Syphilis.—The pharynx, in common with other portions of the body, suffers from different manifestations of this disease. Among the secondary accidents are erythema, mucous patches, and ulceration. Gummy tumors belong to the later or tertiary period, and elect the posterior wall of the pharynx. The diagnosis of these affections must rest on the antecedent history of the patient, and also on other traces of the disease which will probably be present on the body.

Erysipelatous Pharyngitis.—In cases of erysipelas of the head, neck, or face, an inflammation of the fauces and pharynx sometimes arises, which, from its diffused character and its tendency to infiltrate the submucous tissue, has been designated erysipelatous. A similar condition attends aggravated or malignant forms of some of the exanthemata, as scarlatina and variola.

The symptoms are quite unequivocal. The mucous membrane of the fauces and pharynx is red, livid, and œdematous; deglutition is painful or impossible; the swelling may extend to the larynx, accompanied with pain arising from spasm, and cause difficulty of breathing, threatening suffocation. The tongue becomes dark, and the pulse rapidly fails, and, unless prompt relief is afforded, death may take place in a very short time. The inflammatory infiltration extends to the muscular walls of the pharynx and œsophagus, even reaching the connective tissue along the line of the posterior mediastinum of the chest.

In one case of the disease which I saw, the inflammation resulted in sloughing, which opened the neck externally. When the swelling encroaches upon the glottis, threatening suffocation, the patient may be rescued by a timely laryngotomy.

Abscess and sloughing may be prevented by making free incisions into the mucous membrane, and thereby removing tension, as in phlegmonous inflammation of the skin and subcutaneous tissue. In addition to these local measures, the patient will require to be supported by rectal alimentation, as swallowing under the circumstances becomes impossible. To the nutritious enemata brandy and quinine must be added.

Retropharyngeal Abscess may arise either from constitutional or from traumatic causes. The constitutional causes are disease of the cervical vertebrae, inflammation of the post-pharyngeal lymph glands and connective tissue, and transmitted syphilis. While no age is wholly exempt from this affection, young children, especially those having a scrofulous organization, most frequently suffer. Traumatic cases arise from various foreign bodies becoming impacted in the pharynx.

John Adams* reports two cases in which abscesses formed in consequence of fish-bones becoming fastened in the pouch; and in a paper by Allen† on retropharyngeal abscess, thirty-eight cases of the latter are collected occasioned by different foreign bodies, as pins, bones, sticks, etc. Sinkler‡ met with one case produced by injury to the spine.

Caries of the cervical vertebræ is much the most fruitful source of this form of abscess.

SIGNS.—The earliest signs of this abscess are slight soreness of the throat and some difficulty in deglutition, in consequence of the diminished mobility in the walls of the pharynx. The posture of the head is significant, particularly when bone disease exists, as it is then carried in a stiff, erect position, often only turning with the body when it is necessary to direct the attention to some object on one side. As the tumefaction in front of the spine increases unless limited by adhesions, the swelling tends to descend, dissecting the posterior wall of the pharynx away from the bodies of the vertebræ; this is followed by more or less difficulty in breathing, snoring during sleep, and possibly by spasmodic suffocative attacks. The abscess may be placed on one side of the pharynx or directly behind the middle of its posterior wall; the neck behind the angle of the jaw on the corresponding side is swollen. Rigors, followed by a hot skin and febrile disturbance, are generally present at some stage of the suppuration.

DIAGNOSIS.—The gradual progress of the disease, the lameness of the neck, the presence of an elastic, probably fluctuating, swelling behind the pharynx, determined by the direct application of the finger to the parts, together with the difficulty of swallowing and the intermittent attacks of dyspnoea, but no loss of voice, make it highly improbable that an abscess of this kind will be confounded with either croup or œdema of the larynx.

Among Allen's cases, mentioned above, was one which had been mistaken for syphilitic disease. This error can scarcely occur if proper care is taken in the investigation, since in the latter affection there are usually external symptoms.

PROGNOSIS.—The prognosis in retropharyngeal abscess is exceedingly grave. When induced by disease of the spine, it is almost always fatal. Of the 38 cases of this abscess collected by Allen, and to which reference has been made, only 3 cases are represented to have recovered. All of Stromeier's cases died. Of the 91 cases of Gautier, 41 perished. Bokai gives a more favorable representation, only 11 of his 141 cases proving fatal. All of these except 13 were idiopathic. The result is in singular contrast with the experience of other observers.

Syme and Gunther have each given a case of recovery after the discharge of portions of the vertebræ. In the one recorded by Gunther,§ the third and fourth cervical vertebræ were taken away.

TREATMENT.—During the early inflammatory stage of the pharyngitis, by free incisions, unloading the submucous tissue of the transudation, an abscess may be prevented; but in most instances this opportune moment is allowed to pass. In those cases which originate from disease of the cervical vertebræ, of course no abortive measure of this kind is possible; yet the abscess should always be opened at the earliest possible moment after being discovered.

When the accumulation is large, particularly in the case of children, there is considerable risk of the pus entering the larynx during the evacuation of the abscess. Various precautions have been suggested in order to prevent so grave a casualty. Thus, Sir Astley Cooper and others recommend for the purpose the ordinary trocar and canula. Schmidt advises pressing the epiglottic cartilage over the opening of the larynx with the finger simultane-

* *Lancet*, June, 1847.

† *New York Journal of Medicine*, November, 1857.

‡ *Philadelphia Medical Times*, April, 1875.

§ *Deutsche Klinik*, 1859, p. 34; Cohen, *Diseases of the Throat and Air-Passages*, p. 242.

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ously with the puncture of the abscess. Others would endeavor to effect the same closure of the larynx by flexing the head while the opening is being made. Neither of these last two plans is practicable. The contact of a finger with the epiglottis would cause so much muscular spasm as to render the use of the knife uncertain, if not hazardous, and could not, even if the incision was made, be retained long enough to be of use; while the postural method would require a stab in the dark. When the abscess is high up, there is little ground for apprehending any danger from suffocation; when it is low down, the risk will be diminished by making first a small opening, the head and trunk being bent forward and downward immediately afterwards, so that the contents of the abscess will gravitate towards the mouth, and, after the collection has been well emptied, enlarging the opening, if necessary, by a second incision.

The same advantage would be gained in the case of children by inverting the body with the head downward. The instrument required for the operation is a sharp-pointed tenotome or bistoury.

Another plan, and one entirely free from danger, is by the aspirator, and, when that instrument is at hand, this should be adopted in preference to other means. When, either on account of œdema of the glottis or laryngeal spasm, a patient suffering from retropharyngeal abscess is threatened with suffocation, laryngotomy should be promptly performed.

Scalds and caustic agents.—Children sometimes ignorantly take into the mouth a boiling liquid, or inhale the steam from a tea-kettle or some other vessel, or the same accident happens to adults as a result of the explosion of steam-boilers. In a recent accident on the railroad running from Camden to Atlantic City by the way of May's Landing, in which the engine attached to the second section of an excursion-train ran into the rear car of the first, a number of the killed met their deaths by the inhalation of the steam which rushed into the telescoped car. Caustic liquids, as aqua ammoniac, mineral acids, or lye from ashes, are also sometimes swallowed or taken into the mouth before the mistake is discovered. The violent inflammation which immediately follows the presence of such irritants extends through the mouth, fauces, and pharynx, and is followed by a rapid œdematous swelling that closes the glottis, and, unless timely relief is furnished, may quickly terminate life.

TREATMENT.—When the dyspnœa is not alarming, the application of leeches to the neck, before and behind the angles of the jaws, followed by the external and internal use of ice, may suffice to control the inflammatory congestion and effusion; but if there is increasing difficulty of breathing, no time must be lost in opening the windpipe and introducing a tracheal tube.

Wounds of the pharynx may be homicidal, suicidal, or accidental, and inflicted by dirks, razors, pistols, or guns. In a number of instances they have resulted from the impaction of foreign bodies, as bones, and from the use of instruments. When produced by suicidal attempts, they are generally made through the neck. A wound from the outside, in order to enter the pharynx, must be above the thyroid cartilage in front, and laterally above the level of the cricoid cartilage.

Wounds made with suicidal motives are very often between the thyroid cartilage and the hyoid bone, and, when sufficiently deep, penetrate the lateral walls of the pharynx, severing sometimes the epiglottic cartilage. An incised or a shot wound behind the angle of the jaw, or some distance below it, is in a favorable position for opening the pharynx. Pistols are sometimes fired into the mouth in attempts at self-destruction.

The immediate danger in pharyngeal wounds is hemorrhage: if this is escaped, the remote evils to be apprehended are diffused suppuration and fistula.

TREATMENT.—The first duty of the surgeon in a wound of the pharynx

is to control any hemorrhage which may be present. When inflicted through the front of the neck, it is only necessary to close the cervical wound, if incised, by position; the head being moderately flexed on the breast, and so maintained by a night-cap having bands running from its sides to a circular strip of roller tied round the thorax. (See *Wounds of the Neck*, vol. i. p. 318.)

Mr. Johnson,* of St. George's Hospital, London, was compelled, in one instance, to tie the carotid artery on account of repeated hemorrhages from a wound of the pharynx, inflicted through the mouth by the end of a parasol.

I have not found sutures of much value. Incised wounds which open the pharynx from the side of the neck should be stitched with the silver or the animal thread, the sutures at the same time including the sides of the superincumbent soft parts. If the two wounds—that in the tissues of the neck and that in the pharynx—are closed separately, the latter should be stitched with the animal thread; as the silver or silk ligature, instead of becoming encysted, or ulcerating its way into the pharynx, gives rise to abscess.

If ligatures are used at all, it will be safer to close the pharyngeal wound with the animal thread, and allow that in the overlying soft parts to remain unclosed and heal by open granulation. When both are simultaneously closed, it is highly probable that the secretions from the pharynx will pass through the wound; for I am of opinion that as regards quick reunion, little is to be expected from the threads which may be inserted into the walls of the pharynx.

Gunshot wounds of the pharynx received through the neck are necessarily followed by the detachment of a circumferential slough, and can only heal by open granulation tissue; consequently, artificial closure is not to be thought of.

Shot or punctured wounds of the pharynx inflicted through the mouth may penetrate the spine or the cranium, and are usually fatal.

After arresting hemorrhage and dressing the wound, much depends on the after-treatment. For the first four or five days all nourishment should be administered through the bowel, and at the expiration of this time, if the patient exhibits no signs of exhaustion, this mode of alimentation may be continued for some days longer before the stomach-tube is employed. The objection to the early use of the latter is this, that, whether introduced through the mouth or through the nose, it will for a time provoke some reflex movement in the muscles of the pharynx, which complicates and retards the healing. Feeding the patient by means of the tube ought therefore to be postponed for several days.

Fistula is one of the terminations of a wound in the pharynx. It may also follow an abscess in its walls, or in the adjacent portion of the neck. A distressing case of this kind was under my care in the person of an elderly gentleman of this city, in whom the pharynx was opened by the ulceration caused by the presence of a malignant growth in the neck. The fistula opened immediately above the clavicle, after following a circuitous route. Fluids and particles of food passed through the track of the fistula, and gave rise to other fistulæ in different parts of the neck.

TREATMENT.—Should a fistula, the result of a wound or abscess, not close after a reasonable time, attempts may be made to effect its obliteration by stimulating injections or by cauterization.

The last, which promises most success, can be made by a delicate canula bearing a porte-caustique armed with nitrate of silver, which can be applied to the fistula in the walls of the pharynx without touching other parts of the false passage. The galvano-cautery has been used with success, applied through a hollow canula. In a case which resists other measures, it would

* Holmes's System of Surgery, vol. ii. p. 457.

be proper to use the œsophageal tube for taking nourishment for some time, in the hope that the prevention of the intrusion of any foreign bodies might lead to the closure of the fistula.

Foreign Bodies are occasionally swallowed, either accidentally or intentionally, and, in consequence of their size, become impacted in the pharynx. Among these the most common are plates of artificial teeth, pieces of wood, bones, nails, etc. In one instance reported by Morton, a large comb was the intruding body. (Fig. 1669.)

FIG. 1669.



Comb removed in Morton's case—exact size.

Any substance, large or small, which becomes arrested in the pharynx, gives rise to local irritation, cough, dysphagia, pain, and, when the body is large and presses strongly against the larynx, to dyspnoea, and even asphyxia.

TREATMENT.—In many cases the foreign body can be best removed by passing the finger round it and hooking it out. If this cannot be done, resort must be had to some form of the gullet forceps (Fig. 1674), which sometimes can be used with great precision with the aid of the laryngoscope.

Cicatricial Stenosis.—The capacity of the pharynx immediately posterior to the fauces is liable to become very much diminished from the cicatrization following specific ulcerations. I have seen a number of these cases produced by syphilitic disease. In all, the posterior pillars of the fauces and the soft palate were included in the contraction, materially diminishing the space between the arches. In one case I found the uvula and velum with an elliptical opening and attached to the posterior wall of the pharynx, the latter being also puckered or corrugated with seams of cicatricial tissue. The opening in the soft palate formed the only connection between the post-nasal and the post-faucial division of the pharynx. This condition is followed by more or less dysphonia, and some disability in deglutition, with dyspnoea, and a predisposition on the occurrence of cold to symptoms not unlike croup. The dyspnoea may even proceed to asphyxia and death, as happened in a case reported to me, in which the cavity of the pharynx was almost entirely closed by crossing and interlacing bands of cicatricial tissue following extensive syphilitic ulceration. A severe cold produced a pharyngitis with nasal catarrh and with moderate bronchitis, and the excess of mucus from these sources becoming entangled in the meshes of the fibrous tissue prevented the entrance of air. The patient when seen by Dr. J. Wm. White, who was in charge, was asphyxiated and moribund. Laryngotomy was promptly performed, but the case terminated fatally.

TREATMENT.—Pharyngeal stenosis, in my experience, is not benefited either by incision or by dilatation; on the contrary, they are positively hurtful, and, unless there is a contraction sufficient to prevent the passage of food, instrumental meddling of any kind should be avoided. The best bougie is a bolus of food, which, on account of its frequent repetition, will serve to maintain the passage pervious. If the necessity for an operation should arise, the excision of a piece from the pillars of the fauces will be preferable to making a dilatation.

Dilatation of the pharynx may be either general or local. The former has been observed as the result of anæsthesia or paralysis of its walls. Local dilatation is more common. The formation of these pouches is much the same as that of the sacculated bladder. The sudden lateral impulse during swallowing communicated to the pharynx at the line of its junction with the œsophagus, in consequence of the abrupt contraction of the diameters of the gullet at this point, associated as it often is with a defect in some of the muscular fasciculi of the middle constrictor, causes the mucous and submucous portions of the tube to yield, and to form a button-like pullulation on its side, which, under the repetition of the original cause, finally protrudes between the muscular fibres, forming an elongated pouch (Fig. 1670), in shape not unlike the sac of a hernia. The most dependent portion of the diverticulum, or its fundus, in well-pronounced cases, is the largest and most capacious part of the pouch, the cavity of which communicates with the pharynx by a comparatively small opening. The food may enter this diverticulum in such quantities as to form a considerable tumor in the neck, to be emptied only by pressure with the fingers. Pressure exerted in this way, with collapse of the sac, will indicate a diverticulum. The sound will aid in verifying the continuity of the pouch with the pharynx.

FIG. 1670.



General dilatation and pouched state of the pharynx.

The condition appears to be peculiar to old persons, beginning perhaps in middle life.

Tumors in the pharynx are rare. Carle has resected the pharynx in two cases for carcinoma with success, and Iverson* gives six cases of the same operation for carcinoma, with one apparent cure and recurrence in the remaining five. In two cases the larynx was also removed. Mr. Pollock records two cases which are in the museum of the College of Surgeons, London, one fatty, the other fibrous, both of which had been successfully removed; and Mr. Holt† mentions another, fatty in its character, which was taken from the pharynx of a man far advanced in life, and who probably, from his death

* Annual of the Universal Medical Sciences, vol. iv.

† Holmes's Surgery, vol. iv. p. 488.

having taken place suddenly, perished in consequence of the mass getting into the vestibule of the larynx.

A pedunculated tumor of the pharynx, under favorable circumstances, might be seized and cut off with long scissors curved on the flat, or it might be snared in the loop of a wire *écraseur* and severed by this means.

The danger, when the growth is large, of obstructing the larynx in attempts at removal has given rise to the wise suggestion of performing laryngotomy and inserting a tube as a preliminary step to the operation.

Affections of the Œsophagus.

Congenital Imperfections of the Œsophagus are unusual occurrences. In three cases reported by Mr. Holmes,* the Œsophagus communicated with the trachea, and all ended fatally. Other instances of a similar nature have been observed by Houston, Annandale,† and Marsh.‡ The defect might be diagnosed by the suffocation and cough attending sucking, caused by the milk entering the trachea. In another case reported by Mr. Holmes, believed to be congenital, there was a stricture of the Œsophagus, which had produced an enormous dilatation of the canal above. The patient lived to the age of seventy-four, and died of pneumonia. The ground for supposing the stricture to have been congenital was the fact that the man could never recollect a time when he had not difficulty in swallowing, requiring some liquid with which to wash the food down, and portions of it frequently returning into the pharynx or the mouth.

Malformations of the kind mentioned do not admit of treatment.

Foreign Bodies frequently lodge in the Œsophagus. These bodies vary in nature, size, and shape, the most common being coins (Fig. 1671), bones, pins,

FIG. 1671.



A copper penny impacted in the Œsophagus.—From preparation in the museum of the University of Pennsylvania.

needles, artificial teeth on the plate, and solid masses of food. These bodies are frequently arrested at the junction of the pharynx with the Œsophagus, the opening of which may be likened to that in which the expanded point of a funnel and its neck unite. When the body is so large as to press strongly against the posterior wall of the trachea, the sense of suffocation is so urgent that the patient becomes greatly agitated, instinctively throws the head back, grows dark in the face, and struggles in a wild and excited manner. I believe this is the only accident in which the instinctive efforts of the body tend to destruction, throwing back the head increasing the danger instead of lessening it, by stretching the trachea more forcibly over the impacted body. When the foreign body passes on to the thoracic portion of the Œsophagus, these feelings of suffocation are not present. In whatever part of the gullet the offending substance may be, even though it may not be sufficiently large to create dyspnoea, there will be a feeling of uneasiness, often amounting to pain, aggravated by every act of deglutition, and often accompanied with the abundant secretion

of ropy mucus. The magnitude of bodies which sometimes find their way through the pharyngo-Œsophageal constriction is surprising. A singular case, illustrative of the above, I saw with Dr. Stewart, of this city. The patient, a German, shortly after eating a quantity of sour-crout at a restaurant, missed an entire set of mounted teeth. He remembered that while partaking of his favorite dish he had experienced a scratching sensation, which, however, had given him no special uneasiness. On introducing a probang along the gullet, the teeth were distinctly felt close to the cardiac

* Diseases of Children, p. 136.

† Dublin Hospital Reports, vol. v. p. 310,—Cohen.

‡ British Medical Journal, November 27, 1875, p. 686.

orifice. The inflammatory swelling which existed at the time of our visit not only prevented the passage of liquids, but rendered any attempt to force the foreign body into the stomach unadvisable. The patient died shortly after. A drawing from the specimen is given in Fig. 1672. Were another case of the same kind to come under my care, I should feel justified in opening the stomach, dilating its cardiac orifice, and extracting the body either entire or by instrument after division. As the tube below this point enlarges, the foreign bodies will gradually pass on until near to the œsophageal opening in the diaphragm, when the canal is again constricted.

Bodies may remain for some time in the œsophagus, and be finally dislodged in a fit of coughing or vomiting. They may also, when pointed, cause ulceration, and find their way into adjoining organs or parts of the body. Andrews* gives a case in which a fish-bone passed through the gullet in this manner, entered the heart, and destroyed the patient by hemorrhage. Erichsen† mentions an instance in which a piece of gutta-percha had ulcerated through the œsophagus, and, by opening the œsophageal vessels, caused death by hemorrhage. Mr. Kerby, of Dublin, also mentions a case in which the patient died from hemorrhage, the foreign body, a bone, having perforated the œsophagus and wounded an abnormally placed subclavian artery. Dr. Cohen‡ met with a case in which a gold plate lodged in the tube had caused an ulceration into the trachea at its bifurcation, through which passed substances which had been swallowed, and which were then often ejected from the mouth in a paroxysm of coughing. The same writer records also an instance of a man having swallowed, when a youth, two peculiar-shaped pins, which, thirty years after, were found lodged under the skin of the shoulder. I once removed from the substance of the heart of a bullock an eight-penny nail, which, no doubt, had reached that organ by way of the gullet. Dr. Ogle, of London, gives a case ending fatally in which the medulla spinalis had become diseased from a bone which had been lodged in the œsophagus finding its way into one of the intervertebral cartilages.

A strolling juggler was carried in a state of fatal collapse into the University College Hospital, London. This man, while amusing a street crowd by the feat of swallowing a sword, gave the weapon a forcible push at a point where it became arrested near to the root of the neck, and was seen suddenly to withdraw it, leap spasmodically into the air, and fall to the ground in a faint. After his death the point of the sword was found to have penetrated the œsophagus and entered the pericardium, though neither the heart nor any of its vessels were injured.

TREATMENT.—When a foreign body of a size calculated to give rise to symptoms of suffocation becomes arrested in the œsophagus, much may be accomplished to relieve the urgent sensations by keeping the head of the patient bent forward, and at the same time allaying his or her fears by a few words of encouragement until the means necessary for the extraction of the body can be obtained. The only domestic remedy—a good thump on the back—is not to be despised, and has in many instances dislodged from the throat of a child a piece of meat or other substance which had become arrested at the top of the gullet. The particular instrument best adapted to extract a foreign body will depend altogether on the character of the latter. A pin,

FIG. 1672.



Plate of artificial teeth in the œsophagus.

* London Lancet, 1860.

† Erichsen's Surgery, vol. II. p. 484.

‡ Diseases of the Throat, etc., page 313, 2d ed.

needle, or splinter can often be removed by the forceps of Bond. (Fig. 1673.) The blades of this instrument are wedge-shaped, and the summit of each

FIG. 1673.



Bond's gullet forceps.

blade is serrated. The mechanical advantage of this arrangement consists in the tendency of the body, when caught, to turn in a direction parallel with the blades of the instrument, and thus be more easily extracted. Coins, pieces of bone, and mounted artificial teeth are most readily seized and removed by forceps fashioned like that represented in Fig. 1674, or by means

FIG. 1674.



Gullet forceps.

of the swivel. (Fig. 1675.) A body which is fixed in the œsophagus cross-wise may sometimes be detached from its position by a blunt hook passed

FIG. 1675.



œsophagus swivel.

beneath one of its ends and retracted, after which the forceps can be employed for its removal, or it may be ejected by the efforts of the patient.

FIG. 1676.



Horse-hair snare, closed and open.

When both these devices are unsuccessful, the horse-hair snare (Fig. 1676) will often accomplish the object.

The instrument closed, and its extremity oiled, is passed down along the

œsophagus below the point of obstruction, when it is expanded, the hair forming a kind of parachute, in which state it is to be withdrawn, when the entire circumference of the gullet will be swept.

An ingenious method for extracting a fish-hook to which a portion of the line was attached, and which had become fixed in the œsophagus, was devised by Dr. Bright, of Kentucky. The line was passed through a perforated bullet, and as the latter passed down the cord the hook was disengaged by the momentum and weight of the lead, and successfully removed.

Bodies whose exterior is round and free from points and angles, and which cannot be extracted, may be safely pushed into the stomach. Masses of food which become arrested from being disproportioned to the capacity of the tube may be treated in the same way.

The sponge probang (Fig. 1677) is best adapted for this purpose. In either

FIG. 1677.



Sponge probang.

withdrawing foreign bodies from the œsophagus or pushing them down, no unnecessary force or rude manipulation should be practiced, as irreparable injury may be done to the tube in this way.

In a few cases of bodies impacted in the cervical portion of the gullet, œsophagotomy may be required. Pins, needles, coins, bullets, and various indigestible substances are often swallowed by children, and are either temporarily arrested in the gullet or pass straight on into the stomach. These are seldom followed by any evil consequences. The treatment in cases of this kind has been given under the head of foreign bodies in the stomach (vol. i. p. 392).

Wounds of the œsophagus are sometimes produced in attempts at suicide by cutting the throat. The tube may be opened by a stab in the neck. I have known the accident to occur in an attempt to pass an instrument through a stricture. Rupture of the œsophagus has followed during vomiting. Two cases of the kind are noted by Durham,—one related by Boerhaave, that of a prominent baron, who, being greatly addicted to the pleasures of the table, was in the habit of voluntarily exciting vomiting in order to avoid the evil effects of such indulgence. In one of these efforts he was attacked with great distress in the chest, and shortly after died. The œsophagus, on examination, was found torn. The other case was reported by Dr. Griffin, in the *Lancet* for September 4, 1869. Dryden and Gramatzki each give an instance of rupture following a drunken excess, and Mr. Adams* has recently reported an accident of the same nature. The patient had been a gouty, dyspeptic subject. Shortly after eating a quantity of beefsteak, he was attacked with pain and retching, becoming pale, and passing into a state of collapse. Death followed in eight hours, and on examination the œsophagus was discovered to be ruptured immediately above the diaphragm, and the contents of the stomach lying in the left pleural cavity. A piece of hard gristle which had been swallowed was supposed to have been the cause of the lesion. In all these cases there was probably some degeneration of the muscular walls of the tube.

* *British Medical Journal*, June 15, 1878, p. 865.

TREATMENT.—It is only when the lesion occurs in the neck that surgical measures are practicable. The great danger is hemorrhage from the large vessels of this region, which often proves fatal before aid can be obtained. The duty of the practitioner is first to secure all bleeding vessels, and then to bring the edges of the œsophageal wound together with interrupted sutures, using for the purpose the animal thread, and leaving the wound in the superincumbent soft parts open, as in like injuries of the pharynx.

Fistula.—Fistulous openings in the neck communicating with the œsophagus are occasionally observed, both congenital and acquired.

Acquired fistula is among the sequels of wounds of the œsophagus, and is exceedingly intractable to treatment. The external openings appear usually in the neck, and often follow quite a circuitous course, opening upon the surface at some point remote from where the communication with the œsophagus exists. An œsophageal fistula is recorded by Coghill* which opened through the parietes of the chest, following what was supposed to be pleurisy, accompanied by congestion of the lungs.

The escape of alimentary substances, both solid and liquid, through the external opening establishes the diagnosis of œsophageal fistula.

TREATMENT.—Injections of the fistulous track with solutions of the sulphate of copper and nitrate of silver, which are recommended, promise very little success. Cauterization by nitric acid applied by means of a silver probe, equivalent to the use of nitrate of silver, or the galvano-cautery, will give a better result. But when the sinus is direct,—which can be determined by the probe,—or even when indirect, laying the entire length of the track open and commencing anew the work of repair offers the best chance for a cure.

This operation is a delicate one, and for its execution requires that a fine probe be passed along the fistula as a guide for the incisions, which are to be made with due consideration for the vessels that may be encountered. If the course of the fistula is tortuous, so that the probe can traverse only a small extent of the abnormal channel, the latter should be divided to that extent, when a way will be opened for a second introduction of the guide, and so on until its internal orifice has been reached. Other methods should always be tried before resorting to such an operation, which requires exceptionally accurate anatomical knowledge. The wound, after incision, must be treated on the same principles as when made for fistulæ in other parts of the body, namely, by introducing a pledget of lint and allowing it to close by granulation tissue.

Retro-œsophageal Abscess.—A retropharyngeal may become a retro-œsophageal abscess by simple extension, the matter dissecting its way down into the neck. When the abscess is independent of such an origin, it may arise from disease of the cervical or dorsal vertebræ, from stricture of the œsophagus, or, as in one of my own cases, from a malignant growth of the larynx.

SYMPTOMS.—When the abscess is an extension from the postpharyngeal region above, the larynx will be prominent in common with the trachea, and the swelling will be chiefly on the right side, in accordance with the position of the œsophagus. The trachea will also be thrust over towards the left side, and the head inclined forward in order to relax the air-tube and lessen the difficulty of breathing. The voice, according to Duparcque, is also diagnostic, being shrill and piping. Deglutition is not altogether impossible, though the fluids which are taken may be detained for a few moments before passing down. Should they regurgitate, they are liable to enter the larynx.

Retro-œsophageal abscess, when it occurs within the thorax, must take place somewhere above the ninth dorsal vertebra. It is almost always among the secondary effects of caries of the dorsal vertebræ, though it may follow traumatic causes, as the use of the probang or the impaction of false

* British Medical Journal, July 20, 1877, p. 68.

teeth. When the result of spinal disease, it constitutes spinal abscess, and only when, as is sometimes the case, the pus finds its way to the loin or the groin can it be diagnosed.

TREATMENT.—Should the breathing become so difficult as to threaten life, tracheotomy will be demanded, and ought not to be too long delayed. If the signs of the abscess are sufficiently clear, a formal dissection of the neck, as in œsophagotomy, should be unhesitatingly performed with a view to open a way for the escape of the pus.

Stenosis.—Narrowing of the canal of the œsophagus arises from two general sets of causes,—extrinsic or functional and intrinsic or organic. The extrinsic may be divided into mechanical and reflex or spasmodic. The former are enlargements of the lymphatic glands of the neck or the bronchial glands in the thorax, retro-œsophageal and periesophageal abscess, aneurism of the carotid or of the innominate artery, malignant growths in the neck or within the thorax, and, in rare instances, dislocation of the sternal extremity of the clavicle.

Many of the causes are not susceptible of being removed, for example, malignant intrathoracic or cervical growths. Whenever the cause falls within the pale of operative or therapeutic measures, the relief of the stenosis is insured.

Reflex stenosis will be considered under the head of neuroses of the œsophagus.

Intrinsic or organic stenosis (stricture) depends on a structural alteration in the walls of the gullet, not only destroying the dilatability of the tube, but also narrowing its canal.

The most common among the causes producing this form of stenosis are carcinoma and cicatricial contraction from caustic alkalies and acids. Indeed, the former outnumber all other causes combined. Carcinoma, which is always epithelial, is most frequently located somewhere in the last four inches of the œsophagus. In the cases collected by Peter, Zenker, and Ziemssen, amounting to twenty, 14 were in the lower and middle portions of the tube, 4 in the middle, and 2 in the upper third. In rare cases the disease has been seen to involve the whole length of the gullet. Professor Harrison Allen,* who has analyzed a considerable number of œsophageal obstructions from different causes, regards the portions of the tube most liable to pathological or mechanical stenosis as the part behind the cricoid cartilage, and that which is crossed by the left bronchus.

The infiltration which begins in cancer in the submucous tissue of the canal gradually extends to all its coats, until not only does it encroach on the interior of the tube, obstructing its cavity, but at length forms a large mass externally. (Fig. 1678.) Elderly persons are usually the subjects of œsophageal cancer. Females are said to suffer more frequently than males; but according to my observation the disease is equally common in both sexes.

When the stricture is produced by caustic agents, it must be referred to the new connective tissue which takes the place of the destroyed mucous and submucous components of the tube, and the contraction of which causes the narrowing; and the same is true of those coarctations which follow the healing of

FIG. 1678.



Carcinoma at the lower part of the œsophagus.

* Localization of Diseased Action in the Œsophagus.

sypilitic or other ulcerations of the œsophagus. The subjects of this variety of stenosis are children or persons in middle life.

The obstacles offered to the passage of food in the two classes of cases, namely, the carcinomatous and the cicatricial, are, therefore, unlike; in the former it is obstructed by the growth of the tumor, involving or destroying most of the coats of the tube, while in the latter the canal is lessened by the contraction of its own walls: hence the term organic stricture should, strictly speaking, be applied only to stenosis from cicatricial causes. In both cancerous and cicatricial cases, however, two obstacles to the transmission of the bolus of food along the gullet are always present, namely, disability from the failure of peristalsis, and the loss of the proper lubricating fluid.

Stenosis exists in all degrees, from the slightest narrowing to almost complete closure. The form of the contracted orifice is sometimes angular, and at other times irregularly oblong or fissure-like.

SYMPTOMS.—The earliest symptom of œsophageal stenosis is some imperfection or disturbance in deglutition. The difficulty is first observed in swallowing solids. There is a brief interruption in the passage of the bolus; it sticks, not so much from the diminished calibre of the canal as from the impaired capacity of the circular and longitudinal muscles to effect the physiological modifications in the length and diameter of the tube. As the morbid process progresses, increasing the narrowing or obstruction, the difficulty of deglutition is often accompanied with a feeling of uneasiness, pain, and constriction in the chest, with occasional attacks of dyspœnea and eructations of wind. Often the food, after sticking fast for a short time, is returned into the pharynx, when a second effort will be made to swallow it. If the stenosis is seated low down, a considerable quantity may accumulate in the gullet, and remain, perhaps, days before being regurgitated, and even then the substances may be again swallowed before reaching the pharynx.

The resistance which the food encounters at the seat of coarctation, with the constant repetition of the peristaltic power in swallowing, often causes the œsophagus to become greatly dilated or expanded above: in one case that I examined after death, this pouch rivaled the stomach in size.

Sometimes the arrest provokes vomiting, and the contents of the stomach are ejected along with the œsophageal accumulations. After a time solids are entirely discarded, and liquids, which in the early history of the case pass along the tube without being delayed, are alone used, and these finally are arrested, but gradually trickle through. The difficulty experienced in taking a sufficient amount of nourishment soon begins to tell on the patient. The strength fails, the flesh wastes, and, in malignant stricture, the color of the face reveals the deadly nature of the affection. When the stenosis is the result of caustic agents, the stricture is often very irritable, the contact of the blandest food, solid or liquid, being quite sufficient in some instances to excite spasmodic contraction of the gullet and the violent expulsion of its contents. In addition to the symptoms already given, there are others which have been noted, as the scaphoid form of the epigastrium and the sunken appearance of the left hypochondriac region.

Auscultation and percussion have been employed in cases of œsophageal stenosis. Hamburger, whose name is most prominently associated with the method, attaches much importance to the evidence which may be gained by applying the ear to the left side of the spine, at any point between the fifth cervical and the eighth dorsal vertebra. When a liquid is passing through a healthy gullet, the gurgling sound of the fluid can be distinctly heard. It is alleged that when a stricture exists this characteristic noise will cease, or will be lessened in intensity, at a point corresponding to the narrow portion of the œsophagus. To my own ear, when I have tried it in cases of this nature in order to verify the claims made for auscultation, the result, I must say, has been negative, although it is possible a larger experience may compel me to modify this statement.

DIAGNOSIS.—As œsophageal stricture may be closely imitated by nervous disturbances of the tube from hysteroid or psychical states, it is important that no mistake should be made in this particular. The reality of the stenosis will often be apparent on inquiry, there having been a history of injury to the œsophagus from the accidental swallowing of some caustic material. In narrowing from external pressure or from organic change in the tube, the difficulty in deglutition will have been progressive. Moreover, the loss of flesh and strength, and the pinched, wan, and anxious cast of the face, which attend the imperfect nutrition of the body, are not seen in stricture which arises from emotional causes.

When the diagnosis is obscure, the use of the œsophageal bougie will serve to solve the difficulty. For this purpose a long rubber catheter or bougie, with olive-shaped extremity, should be passed, after the manner to be presently described, or, should one possessed of more firmness be necessary, a whalebone instrument can be employed.

The diagnosis of the stricture being established, it is important to ascertain the nature of the cause. We have already observed that a very large proportion of all cases of œsophageal stenosis are from cancer. If, therefore, the stricture occurs in a patient who has passed the meridian of life, or who is aged, the probabilities are largely in favor of its cancerous origin, and if, in addition, the person is losing flesh and has a cachectic appearance, the evidence will amount almost to certainty.

When the stenosis is caused by external pressure, a careful inquiry into the antecedent history of the case will become necessary in order to form any just idea on the subject of causation. If it arises from the pressure of an aneurism, there will be the characteristic bruit, and possibly an external tumor, both of which signs will probably have been recognized before the œsophageal symptoms appear.

Spinal or retro-œsophageal abscesses will generally have been revealed by pre-existing signs of caries and symptoms of hectic.

Syphilitic stenosis is a disease of middle life, and may be suspected if the patient has been the subject of previous specific lesions.

PROGNOSIS.—Organic stricture of the œsophagus is an incurable affection, and even when the stenosis is due to mechanical pressure it will often admit only of palliation. When due to malignant disease, life is seldom prolonged beyond two or three years. Stricture from caustic agents, if the patient escapes the immediate dangers of inflammation and is of tender years, may not materially shorten life.

TREATMENT.—The treatment of œsophageal stenosis demands the greatest care and sound judgment. It is mechanical and medicinal.

The indiscriminate use of bougies is calculated to do an immense amount of harm. When the obstruction has been traced to a malignant cause, the use of bougies should be discarded. I am fully convinced that in such cases instrumentation of any kind is an unmitigated evil. Bougies, under these circumstances, provoke irritation and swelling, and excite a more rapid growth in the neoplasm. The proper course to pursue in malignant cases is to support the patient on liquids, as milk, animal broths, and gruel.

No stimulants should be taken by the mouth, and when from any cause there occurs a temporary narrowing of the stricture from congestion or spasm, the nourishment should be administered altogether by the rectum, while at the same time a mixture of bromide of potassium and tincture of belladonna is exhibited internally until the swelling subsides. I feel confident that by pursuing a course of this kind the comfort of the patient will be best secured and life will be prolonged.

When the occlusion of the œsophagus is the result of external pressure, the tube itself being sound, and when, in consequence, a serious impediment is offered to the passage of food, nourishment can be introduced into the stomach by carefully passing the œsophageal tube, which, except in extreme cases, can be done without any great difficulty.

It is in cicatricial stricture that the use of bougies finds its proper application, and even here the nice point to determine is just how often their introduction should be practiced. It has occurred to me to have an unusual number of cases of cicatricial stenosis, especially among children, the class of persons most commonly affected, and as my experience extends I find a growing disposition to lengthen the time between the periods of dilatation, rarely deeming it necessary to introduce a bougie oftener than once in four or five days; the intervals should usually not be longer than two weeks. It is best to commence the dilatation with a gum bougie, and after the stricture has become accustomed to the contact of the soft instrument the latter should be substituted by one constructed entirely of whalebone, very flexible, and with olive-shaped extremities of graduated sizes (Fig. 1679), or the extremities may consist of ivory or hard rubber, securely riveted or, what

FIG. 1679.



Author's whalebone bougie in one piece.

is better, screwed to the end of the whalebone. (Fig. 1680.) This last precaution is one of importance, as I have known the extremity to come off while being used and to remain in the œsophagus. Nothing is to be gained by forcible measures. The dilatation must be carried on patiently, increasing very gradually the size of the bougies.

FIG. 1680.



Bougies with hard-rubber extremities.

Belladonna will be found a valuable adjuvant in these cases, rendering the stricture more tolerant of the instrument and preventing spasm of the œsophagus.

Strictures arising from syphilis yield to large doses of iodide of potassium.

The introduction of bougies, probangs, etc., into the œsophagus should always be done with the patient in the sitting posture. The objection to attempting this procedure while the person is lying down is not only the inconvenience of the position, but the risk that in case any matters should be vomited they might enter the larynx. With children who are timid and struggle, the operation will be facilitated by a few inhalations of chloroform or a slight etherization.

The mouth being opened and the jaws kept asunder by a piece of soft wood or a cork with a string attached, inserted behind the molars of the upper and lower maxillæ, and the head thrown well back to bring the fauces, pharynx, and larynx approximately on a line, the instrument, previously well oiled, is carried directly back to the posterior wall of the pharynx, guided by a finger to guard the opening of the larynx, when, the handle being raised, the bougie, sound, or probang, as the case may be, can be pushed onward into the œsophagus. This canal being reached, the future management of the instrument must be determined by the object in view, whether that is the extraction of a foreign body, the dilatation of a stricture, or the introduction of fluids through the stomach-tube, never forgetting that no undue force is allowable, especially when the tissues of the gullet are altered by disease, thus endangering perforation of its walls.

Internal œsophagotomy has been practiced in a number of cases of stricture,

by means of the œsophagotome, a long tube carrying a concealed knife, which can be protruded or withdrawn at pleasure, and with which the stricture is nicked. Though the operation has been performed some twenty times, yet, being done in the dark, it is not unattended with danger.

Strictures have been divided from the inside with a delicate blunt-pointed knife or tenotome after making an external œsophagotomy. In non-malignant impassable strictures not lower than the cricoid cartilage, and impervious to liquids, œsophagotomy will be proper, and, if seated below the neck, gastrostomy may be required.

Gastro-œsophageal dilatation.—In cases where the stricture is located at the cardia, it has been suggested by Schede to open the stomach and dilate the stricture either by the finger or by a divulsor. The operation has been performed with some success both by Italian and by German surgeons. A foreign body might be extracted by a similar procedure when situated near the stomach.

Pharyngo-Œsophageal and Œsophageal Pouches, or Diverticula, are also among the affections of the gullet. They arise both from mechanical and from pathological causes. Possibly there may be a congenital diverticulum. Those of the first variety are almost always found at the junction of the pharynx and the œsophagus, and belong, therefore, more strictly to the former than to the latter. They include only a small portion of the circumference of the pharynx, but may become elongated into pendent, pyriform sacs, which hang down between the œsophagus and the spine, and by their size not only divert the food from the main channel, but also by pressure constitute an obstacle to the passage of the aliment which may take the proper route. Œsophageal diverticula, like the pharyngeal, are destitute of a muscular coat, although a few straggling fibres may be seen over their walls. (Fig. 1681.)

Sometimes the dilatation of the œsophagus is general, and accompanied with an unusual development of the muscular layers of the tube, as in the remarkable case of Luschka (Fig. 1682), which seems to have existed from early life, and to have been attended with disease of the stomach and carcinoma of several thoracic glands.

The pathological diverticula are found, for the most part, in that part of the tube which lies behind the commencement of the bronchial tubes, and were first described by Rokitansky.* The formation of these lateral pouches is due to inflammatory degenerations and shrinking of the bronchial glands which lie in contact with the external surface of the œsophagus in the locality specified, and the resulting contraction of the connective tissue which remains. These little pouches may consist of one or of all the coats

FIG. 1681.



Œsophageal diverticulum.—From a specimen in the museum of the College of Physicians.

* Handbuch der Patholog. Anatomie, vol. iii. p. 160.

of the œsophagus,—the mucous membrane having a plicated appearance, the folds radiating from the summit of the sac towards its circumference.

We have no means of diagnosing the existence of these pouches during life, unless, as sometimes occurs, ulceration takes place, opening a communication between their orifices and the bronchial tubes, forming broncho-œsophageal fistulæ: the appearance in the expectoration of alimentary substances,

FIG. 1682.



General dilatation of the œsophagus.

which could have entered the bronchial air-passages only by way of the œsophagus, renders a diagnosis possible.

PROGNOSIS.—A diverticulum of large size may be followed by the same evil as stricture; that is, it may prevent the food from passing into the œsophagus and eventually bring about death from starvation. It might be supposed that such a termination could be prevented by the use of the œsophageal tube; but this may be entirely defeated by the flexion produced in the œsophagus by the pressure of the pouch, and only when the latter was empty would the passage of an instrument be possible.

TREATMENT.—Some assistance the patient can render himself by subsisting principally on liquids, and by making pressure on the diverticulum simultaneously with deglutition.

When these measures prove of no value, and the danger of irritation becomes imminent, the gravity of the case justifies an operation. I am not aware of any such having as yet been performed. The steps of the procedure would consist in exposing the pouch in the neck, and, after isolating it from all adventitious connections, ligating its neck and cutting away the remaining portion a short distance from the ligature. Until the threads come away and the opening is closed, no voluntary deglutition would be admissible, the patient being nourished either through the rectum or through the œsophageal tube.

Varices.—In the submucous tissue of the œsophagus are sometimes seen dilated veins which impart in places a blue appearance to the lining membrane. These veins belong to those which surround the œsophagus. The varices occur in old persons. They sometimes give way, and thus constitute one of the sources of œsophageal hemorrhage. A very ingenious explanation of the tardy appearance of dropsical effusion, which is occasionally witnessed in certain diseases of the liver, has been given, founded on the connection which exists between the portal system and the œsophageal and azygos veins through the gastric vein, and which serves to relieve the portal vessels of a certain degree of distention. The existence of varices

might be suspected in a case of œsophageal hemorrhage by proceeding on the principle of elimination, but the diagnosis would be altogether problematical.

Morbid Growths of the Œsophagus.

With the exception of carcinoma, morbid growths are very rarely met with in the œsophagus. Fibromata and myomata have, in a few instances only, been discovered in this locality.

Carcinoma, as has been observed in connection with stricture of the gullet, is confined chiefly to the lower portion of the tube, and is never seen except in the form of epithelioma, taking its origin in the deeper layers of the mucous membrane. The earliest evidence of its presence is the dysphagia incident to the obstruction of the tube, and its tendency is always to a fatal termination. During its progress secondary deposits of the disease are liable to occur in the liver, lungs, and bronchial glands, less frequently in the other viscera or organs.

Fibromata, or Polypi.—These growths, from their pedunculated form, are found hanging into the œsophagus, but their attachment is almost always at the lower part of the pharynx. The tumor is generally solitary. In one case, that noted by Sir Charles Bell, a number of these bodies were found clustered together both above and below the pharyngo-œsophageal junction. Their pendent position, aided by the pressure of the aliment in descending the gullet, tends to increase their growth in a longitudinal direction. In one instance mentioned by Rokitsansky the polypus had attained the length of seven and a half inches.

Although these growths extend into the œsophagus, they are not always accompanied by dysphagia, and hence they may exist a long time without being suspected, and, being in a position to escape observation, their diagnosis is uncertain. They have been occasionally forced into the pharynx during the efforts made in vomiting, and in this way have been recognized. When in addition to dysphagia there is dyspnoea, the latter occurring after vomiting, and in a male patient,—men suffering oftener from these growths than women,—and there is no history of stricture, the existence of a polypoid growth may be suspected. In formidable cases these tumors have been removed. The method of performing an operation of this kind would be, when the growth was attached by a narrow stalk and accessible, to seize the body of the tumor with a pair of polypus forceps and twist it away from its attachment, or to snare it with the wire noose of a double canula and destroy it by strangulation. The operation should never be undertaken unless the surgeon is prepared, in case the emergency arises, to open the larynx. Where life is seriously imperiled by a neoplasm of this kind, the attachment of which can be located at an accessible point with a reasonable degree of certainty, and where other methods are not available, the surgeon is justifiable in resorting to œsophagotomy.

Sarcoma, like fibroma, when occurring in the gullet, has fixed on the region where the pharynx and the œsophagus join. Being seated at the narrowest portion of the alimentary tube, with no tendency to become pedunculated, the obstructive effects of the disease soon become very marked. Dr. Chapman* met with a case of this kind.

The disease does not admit of any radical treatment.

Parasitic growths of vegetable origin have frequently been met with adherent in patches to the mucous lining of the œsophagus, and in a few instances, as in those reported by Virchow and Buhl, even filling up the entire tube and causing death by obstruction. These masses consist of a net-work

* American Journal of the Medical Sciences, October, 1877.

of filaments (the *oïdium albicans*), and are identical in character with those fungi found in the mouth which give rise to *thrush*.

Letzerich has described a parasitic growth which he detected in the œsophagus of a child, and which was made up of micrococci imbedded in the œsophageal mucus, they having reached their new habitat by being transferred from portions of wall-paper which the child had scraped from the room and carried to her mouth. The microscope alone could reveal the existence of such growths in the discharges from the gullet, and when discovered the internal use of salicylic or carbolic acid would be indicated.

Neurosis of the Œsophagus.

Spasm.—Spasm of the œsophagus (*œsophagismus*) is characterized by a sudden partial or complete inability to swallow, accompanied by a feeling of constriction, pain, and glowing heat in the chest or neck. In the attempt at deglutition, the food, when the spasm is seated in the cervical portion of the tube, is often returned into the mouth, or, if the obstruction is in the thoracic portion, rumination will be incomplete, the substance rising and again being swallowed. These attacks are liable to be provoked under very different physical conditions. Thus, with some persons hot liquids, and with others cold, will excite a spasm. A paroxysm is often induced under emotional influences, as joy, grief, surprise, anger, etc. The *globus hystericus* is attributed by some writers to this cause, the feeling of the ball rising upward to the throat being supposed to depend on a reversed peristalsis of the muscular fibres of the œsophagus. No such action, however, has as yet, I believe, been demonstrated to occur in these muscles: so that the explanation is entirely a hypothetical one. Women are more subject to these spasmodic attacks than men; even childhood is not entirely exempt from the affection.

The spasm may be transient, affecting the tubes for a few moments, or it may last for hours, days, or weeks. A few rare cases have been recorded in which the disease continued for years,—in one instance fifteen years, and in another thirty years.

The pathology of œsophageal spasm is obscure, but there are strong reasons for believing that the affection is always the result of irritation acting directly on the peripheral loops of the pneumogastric nerves, or reflected from other nerves to the latter, or, finally, transmitted from central irritations, physical or psychical.

DIAGNOSIS.—The diagnosis of spasmodic stricture is sometimes quite embarrassing. The functional nature of the affection can only be positively established after a careful inquiry into the history of the case, aided often by an instrumental examination. In conducting an inquiry of this kind, the first consideration would be the sex of the patient, œsophageal spasm being almost peculiar to females. Second, the constitutional temperament. An emotional woman whose antecedent life had been characterized by nervous disturbance of different kinds would, on this account, be a favorable subject for spasm. Third, manner and circumstances of attack. Was the invasion sudden, and not introduced by a considerable period of prodromes, and was it preceded by any physical or mental excitement calculated to disturb the nervous system? These are very important questions, as organic stricture and its effects are progressive, not sudden, and are not likely to follow some wave of temporary feeling or excitement. Fourth, the duration of the attack. Spasmodic coarctation of the œsophagus often leaves as suddenly as it comes on, and a considerable interval may intervene before a second attack is experienced. When a physical exploration is made of the œsophagus, and the sound encounters the stricture, if the latter is spasmodic the spasm will probably be intensified; but if the point of the instrument is allowed to remain for a short time in gentle contact with the contracted part of the tube, without any effort to force a passage, the walls will be found presently to relax, and in a little while will allow the bougie to pass without resistance.

TREATMENT.—If the pathological view advanced for the explanation of œsophageal stricture is correct, then it is the duty of the physician to endeavor to ascertain where the seat of irritation is. If in the canal itself, and not dependent on a positive lesion of its walls (a fact which will be rendered probable by the spasm being excited only by local impressions, as swallowing liquids at a certain temperature, or solids of a peculiar kind, or on the passage of an œsophageal sound), then the treatment which consists in frequently passing bougies and stretching the walls of the tube, with the internal use of iron, assafoetida, and strychnia, and an active out-door life, will secure the best results. When, coexisting with spasm, there can be discovered uterine, gastric, or vesical disease, or any other lesion, irritations from which might be transmitted to the nerves of the par vagum, the correction of such will be clearly indicated as preliminary to all other treatment. In all cases, arising from whatever cause, attention must be paid to the general health, for the improvement of which a judicious combination of tonics and antispasmodics should be administered. Among the latter, bromide of potassium will prove particularly beneficial, from its well-known property of diminishing cerebral sensibility. A treatment of this kind, supplemented by a change of air, scene, and companionship, can scarcely fail to work a cure in due time.

Paralysis.—The œsophagus sometimes participates with the pharynx, tongue, lips, and other muscles of the mouth in a loss of power due to structural degeneration in the medulla oblongata (bulbar paralysis), and which admits of no remedy. Œsophageal paralysis may also occur to some extent among the phenomena of diphtheria, syphilis, and lead-poisoning, and also in general paralysis, as witnessed in concussion of the brain. Other causes which are not central are capable of inducing loss of muscular power in the tube. Thus, its walls may be disabled by over-distention, by carcinomatous infiltration, or by the interruption of nerve-power in consequence of wounds or of pressure from tumors and inflammatory accumulations.

SYMPTOMS.—Among the most prominent of these is dysphagia, the degree of which will depend on the partial or general extent of the paralysis, and also on the extent to which the sensory endowments of the tube are impaired. The food is arrested after entering the œsophagus, remaining there until urged onward by successive installments of aliment and repeated draughts of liquids, until, at length, it reaches the stomach. The disease is not attended with pain, nor is the food returned with the same frequency as in coarctations of the tube.

DIAGNOSIS.—Paralysis of the œsophagus can be distinguished from stricture by the fact that large masses of food are swallowed with greater ease than smaller ones, and solids with less difficulty than liquids; neither is there any difficulty experienced in the introduction of the sound.

PROGNOSIS.—When dependent on syphilis, diphtheria, the poisonous effects of lead, or the presence of inflammatory effusions or hemorrhages capable of being removed by the absorbents and veins, there is a fair prospect of recovery, though the progress will be slow. When the paralysis is due to central causes, recovery can be anticipated only to the extent to which such causes are removable.

TREATMENT.—Paralysis dependent on the constitutional operation of syphilitic, diphtheritic, or lead poison requires that these conditions shall be corrected by appropriate treatment: if the muscular power does not then return, strychnia should be administered until its peculiar constitutional effects are obtained. In the absence of motor power in the walls of the œsophagus, the food which collects in the tube may require to be pushed onward into the stomach by the probang; or, when the deglutition is very imperfect, it will be better to support the patient by introducing the nourishment through the œsophageal tube.

Œsophagotomy.

The operation of opening the œsophagus by an external incision was first suggested by Verduc, in 1643. In 1747, Guattani, a distinguished Italian surgeon, by experiments on animals and on the human cadaver, showed that there was no serious anatomical obstacle in the way of its execution, and in addition reported two instances in which the œsophagus had been opened successfully on account of foreign bodies which had become impacted in the tube,—the one by Goursault, of Limousin, in 1738, and the other by Roland. In 1820, Berlinghieri, at Pisa, introduced an instrument into the œsophagus through the mouth, intended to cause the wall of the gullet to swell so that it could be certainly exposed on the side of the neck, between the superior and inferior thyroid arteries. Begin was the first to formulate definitely the rules for the performance of the operation, based on his own personal practice and observation. He modified the methods of Guattani and Boyer. The former exposed the œsophagus between the trachea and the sterno-hyoid and thyroid muscles, and the latter between the sterno-hyoid and sterno-cleido-mastoid muscles. Begin opened the space between the trachea and sterno-hyoid and sterno-thyroid muscles on one side, and the sterno-cleido-mastoid muscle, carotid artery, internal jugular vein, pneumogastric and sympathetic nerves on the other.

In 1844 œsophagotomy was performed by Watson, of New York.

Circumstances requiring œsophagotomy.—The circumstances which require a resort to this operation are:

1st. The presence of a foreign body impacted in the cervical portion of the œsophagus so firmly that all measures employed for its removal have failed.

2d. The presence of a malignant or other growth in the lower part of the pharynx or the commencement of the œsophagus, which prevents the passage of the food.

3d. The removal of a morbid growth, the form and position of which are favorable to an operation, through the neck, when the operation is not feasible through the mouth.

OPERATION.—The patient should be placed on the back, the shoulders moderately elevated, and the head thrown back and turned towards the right side. An incision is now commenced on the left side of the neck, midway between the thyroid cartilage, half an inch below its upper border, and the sterno-mastoid muscle, and carried down parallel with the anterior border of the last-named muscle, terminating about one inch above the sterno-clavicular articulation. The skin being divided, the superficial fascia and platysma myoides muscle are to be raised on a director and divided to the full extent of the first incision, taking care not to injure the anterior jugular vein, which usually is found along the inner edge of the sterno-mastoid muscle. The deep fascia, now exposed, is incised in like manner, when the sterno-hyoid and thyroid muscles will be seen lying along the inner side of the wound, the sterno-cleido-mastoid muscle and the sheath of the carotid vessels on the outer side, and, some distance below, the tendon of the digastric muscle. The sheath containing the carotid artery, internal jugular vein, and pneumogastric nerves must now be pushed in an outward direction, while the loose cellular tissue between the vessels and the trachea is to be broken up with the director or a finger, taking care not to injure the superior thyroid and inferior thyroid arteries. The œsophagus will now be exposed, lying between the trachea and the vertebræ, and at the middle of the neck, a little to the left side of the trachea. The recognition of the œsophagus may be determined in three ways: first, the foreign body, when the operation is for the removal of such, can be felt through the walls of the tube; secondly, by introducing a sound or bougie through the mouth and pharynx into the gullet, and protruding the side of the latter on its point; thirdly, by observing the alternate distention and collapse of the tube in the acts of inspiration and expiration.

These respiratory movements of the œsophagus I noticed while assisting Dr. Packard, of this city, in a case of œsophagotomy.

After the tube has been identified, its sides should be raised with the forceps and punctured, when the opening can be enlarged in a longitudinal direction to the required extent by either a blunt-pointed bistoury or scissors. When the object of the operation is to nourish the patient, the rubber œsophageal tube is to be introduced through the wound, and a portion of the latter closed above and below by sutures. When the operation is done for the extraction of a foreign body, it should be closed, and the subsequent management of the case, as regards both dressing and after-treatment, will be the same as that described for wounds of the œsophagus.

Intra-thoracic œsophagotomy has been proposed by I. Nassiloff for the removal of foreign bodies and growths occupying this section of the tube.

OPERATION.—An incision is made parallel with the inner border of the scapula seven to nine centimetres external to the spinous processes of the vertebrae. From each extremity of this incision another is made forward three inches or more, and the flap reverted. The four ribs thus exposed are next resected, and the pleura carefully pressed forward until the œsophagus is exposed, when it is to be opened, the foreign body extracted, and the wound sutured with the animal thread, after which the flap is to be replaced and stitched. If a malignant growth is present, it is directed to resect the œsophagus and stitch the lower extremity to the external wound.

Œsophagostomy, the operation of Nassiloff, is designed to form a fistulous opening between the surface of the neck and the gullet in cases of stricture or morbid growths. Of 18 cases, 4 recovered, 10 remained without known benefit, and 4 died.

The operation of pharyngotomy does not differ materially from that of œsophagotomy, except that the incision commences on a level with the great horn of the hyoid bone and terminates one inch below the cricoid cartilage. The ligation of the superior thyroid artery will probably be required, as it crosses the track of the incisions.

RESULTS.—In 1848, De Lavacherie presented to the Belgian Academy of Medicine an analysis of 83 cases of œsophagotomy, of which number 18 were speedily fatal, 17 died from various subsequent complications at longer or shorter intervals, 12 died from hemorrhage, 26 were followed by serious ill results, though not proving fatal, and 10 were followed by abscesses, with escape of the foreign body in that way.

Internal œsophagotomy was performed in two cases by M. Dolbeau on account of œsophageal stricture caused by sulphuric acid. The patients were both females, and both recovered.

Since 1880, the date of the compilation of the table given on the following three pages, which embraces 36 cases of external œsophagotomy, there have been recorded 37 additional cases, with 13 deaths, making a total of 73 cases, with 22 deaths.

Gross, however, has collected 82 operations, with 63 recoveries and 19 deaths,—a mortality of 23 per cent. These operations were done for foreign bodies, and the causes of death in 16 of the fatal cases were abscess, exhaustion, septicæmia, and pneumonia.

Ashhurst in 65 cases of œsophagotomy gives 52 recoveries.

The last recorded cases of œsophagotomy are those of McArdle (1), De la Sota (1), Leritte (1), Clutton (1), Sklifossowsky (3), and Deaver (1),—a total of 8 cases, with 2 deaths.

External Oesophagotomy.

No.	Date.	Sex and Age.	Source of Information.	Nature of Foreign Body.	Point of Impaction.	Treatment before Operation.	Time of Operation.	Result.	Cause of Death.	Operator.
1	1738.	M.	Boston City Hospital Reports, p. 522.	Portion of bone one inch long and six lines broad.	Oesophagus — where not stated: felt outside.	Attempts to push down.	.....	Cured.	.....	Goursault.
2	.....	.....	.....	.....	.....	.....	.....	Cured.	.....	Roland.
3	1831.	M.	Boston City Hospital Reports, p. 522. Amer. Jour. Med. Sci., vol. xlii, p. 251. From Jour. Hebdom., April, 1833, No. 135.	Portion of bone.	Below cricoid cartilage.	Forceps and protrag.	12th day.	Cured.	.....	Beglin.
4	1831.	M.	Amer. Jour. Med. Sci., vol. xlii, p. 251. From Jour. Hebdom., April, 1833, No. 135.	Portion of bone.	Oesophagus, lower part of neck.	Emetics, forceps, and protrag.	8th day.	Cured.	.....	Beglin.
5	1833.	Child.	St. Barth. Hosp. Rep., vol. iv, p. 204. From Med. Chir. Trans.	Fragment bone (spinous process, dorsal vertebra, sheep).	Lower part of pharynx.	Emetics and various attempts to dislodge.	After 5 weeks, on right side, at Middlesex Hospital.	Death in 56 hours.	Pneumonia at time of operation.	Arnott.
6	1842.	M.	Half-Yearly Abst. Med. Sci., vol. iii, p. 215. From Jour. de Chirurg., Nov. 1, 1845, p. 337.	Portion of bone.	Oesophagus perforated; lying on carotid.	.....	8th day.	Cured.	.....	De Lavacherie.
7	1844.	M.	Half-Yearly Abst. Med. Sci., vol. ii, p. 129.	Portion of bone.	Felt outside, over clavicle.	Bleeding, tartar emetic into veins, belladonna enemata, and sixty attempts to dislodge.	4th day: bone swallowed.	Death in 2 days.	Collapse; pharynx gangrenous; stomach inflamed; bone found in rectum.	Martini.
8	1844.	M., 24.	Boston Med. and Surg. Jour., vol. xxx, p. 506. From N. Y. Jour. of Med.	Tuberculous stricture.	Extended into larynx; gullet was opened.	lived two months and then tracheotomy	eight days after done.	Death 1 week after.	.....	Watson.
9	1853.	M.	Boston City Hosp. Rep., p. 522.	Small fish.	Pharynx; tail seen in fauces.	Attempts to draw through mouth.	Several days.	Cured in 6 weeks.	.....	Antoniewicz.
10	1853.	M.	Boston City Hosp. Rep., p. 522.	Fragment of beef-bone.	Oesophagus, in neck.	Attempts to extract.	9th day.	Death 24 day.	Perforation front and behind; retro-pharyngeal abscesses reach stomach.	Flaubert.
11	1854.	F.	Boston City Hosp. Rep., p. 522.	One-franc piece.	Upper part of oesophagus.	Used Graefe's sound and forceps repeatedly.	10th day.	Death 3d day.	Retro-oesophageal abscess opening into pleura.	Demarquay.
12	1855.	.....	.....	.....	Oesophagus; abscess formed.	Could not be reached by forceps.	16th day.	Cured in 2 weeks.	.....	Syne.
13	1856.	M.	Boston City Hosp. Rep., p. 522. Guy's Hosp. Rep., N. S., vol. iv, p. 217.	Gold tooth-plate with false incisor.	Junction of pharynx and oesophagus; no external projection.	Forceps and emetics.	4th day.	Cured in 4 weeks; permanent alteration of voice.	.....	Cock.

External Esophagotomy.—(Continued.)

No.	Date.	Sex and Age.	Source of Information.	Nature of Foreign Body.	Point of Impaction.	Treatment before Operation.	Time of Operation.	Result.	Cause of Death.	Operator.
14	1861.	F., 45.	Brit. Med. Jour., Aug. 24, 1861, p. 103.	Flat piece of mutton-bone one inch square. Copper coin.	Esophagus; no external projection.	Could not be touched by forceps.	6th day.	Cured in 2 weeks.	.....	Syme.
15	1862.	M., 21.	Brit. Med. Jour., March 22, 1862, p. 296.	Fragment of bone two inches long.	Opposite top of sternum.	Touched by bougie.	3 months.	Cured; swallowed in 1 week.	.....	Syme.
16	1862.	M.	Boston City Hosp. Rep., p. 522.	Bone.	Top of esophagus.	Attempts to extract.	2d day.	Cured in 4 weeks.	.....	Inant.
17	1863.	M.	Boston City Hosp. Rep., p. 522.	Peach-stone.	.....	.....	.....	Cured.	.....	Sourier.
18	1864.	M.	Boston City Hosp. Rep., p. 522.	Enlarged cervical gland; gullet dilated to spine and divided into two canals by pendulous scutum.	.....	.....	.....	Cured.	.....	Arnold.
19	1864.	M., 37.	Annals of the New York Acad. of Med., Dec. 1864, Nos. 4, 5, 8, 9.	Codfish-bone.	.....	.....	.....	Death 34th day.	Gangrene of esophagus.	Bruns.
20	1866.	M.	Boston City Hosp. Rep., p. 522.	.....	Junction of pharynx and esophagus; no projection.	Vomiting; finger and prolong; rigors.	3d day (right side).	Cured.	.....	Cheever.
21	1866.	M.	Boston City Hosp. Rep., p. 522.	Brass pin.	Below top of sternum; no projection.	Vomiting; long prolong.	3d day.	Cured in 5 weeks.	.....	Cheever.
22	1867.	M., 33.	Guy's Hosp. Rep., 3d Series, vol. xiii, p. 1.	Silver tooth-plate.	Opposite left cricoid.	Attempts to extract.	.....	Cured.	.....	Cock.
23	1867.	F., 47.	St. Barth. Hosp. Rep., vol. iv, p. 204.	Abscess at cricoid cartilage; reduced to last common pin.	tilage following dilatation before sub-Apparently opposite left cricoid.	tion of stricture; re-mitting to operation. Attempts during four months.	.....	Death 18th day.	.....	Willett.
24	1867.	F., 49.	Boston Med. and Surg. Jour., N. S., vol. i, p. 373.	.....	.....	.....	After 4 months no foreign body found.	Cured.	.....	Hitchcock.
25	1868.	F.	Boston City Hosp. Rep., p. 522.	Supposed to have been a pin.	Junction of pharynx and esophagus.	Various attempts.	After 8 months no foreign body found.	Cured.	.....	Cheever.
26	1869.	F.	Boston City Hosp. Rep., p. 522.	Supposed mutton-bone.	Opposite thyroid cartilage.	None.	10th day, no foreign body found.	Cured; esophageal abscess opened.	.....	McLean.
27	1870.	F.	Boston Med. and Surg. Jour., N. S., vol. vi, p. 81.	A cent one inch in diameter.	Junction of pharynx and esophagus.	Repeated efforts to remove.	5th day.	Cured.	.....	Atherton.
28	.....	M., 11.	Practitioner, by Anstie, vol. vi, p. 186. From Wiener Med. Wochenschrift, No. 56, 1870.	Drank potash - lye seven years previous; two strictures formed.	Swallowed cherry-stone second stricture.	seed, and inability to swallow; seed lodged in second stricture.	2d day.	Cured in 26 days.	.....	Billroth.
29	.....	M., 44.	Practitioner, by Anstie, vol. vi, p. 186. From Wiener Med. Wochenschrift, No. 56, 1870.	Cancerous stricture for over one year.	(Vocal cords paralyzed.)	Used bougies and improved.	.....	Death next day.	.....	Billroth.

External Oesophagotomy.—(Continued.)

No.	Date.	Sex and Age.	Source of Information.	Nature of Foreign Body.	Point of Impaction.	Treatment before Operation.	Time of Operation.	Result.	Cause of Death.	Operator.
30	1874.	M., 30.	Med. Rec., vol. xi. p. 282.	Crescent-shaped (one and one-half inches by one-half inch) gold tooth-plate. Dislodged four false teeth with eleven months and seven days, and formed stricture.	Behind thyroid cartilage.	Attempts with forceps (voice impaired, but recovered).	.....	Cured in 22 days.	.....	McLean.
31	1874.	M.	Med. Rec., vol. xi. p. 282.	Dislodged four false teeth with eleven months and seven days, and formed stricture.	Cardiac portion of oesophagus.	Attempts to remove.	11 months 7 days.	Cured.	.....	McLean.
32	.....	F.	Med. Rec., vol. xi. p. 828. From Journ. de Med. et Chirurg., Nov. 1871.	Fragment of bone.	.....	Attempts to push down.	.....	Cured.	.....	Coslin.
33	1878.	F., 49.	Boston Rec. and Surg. Jour., N. S., vol. c. p. 356.	Flat fish-bone one and three-fourths inches long by one-third inch wide.	Opposite cricoid cartilage in posterior wall of pharynx.	Sponge and bristly probang.	Next day.	Cured in 20 days.	.....	Gay.
34	1878.	F.	Trans. Clin. Soc. of London, vol. xi. p. 233.	False teeth.	Opposite middle of thyroid cartilage, and extending nearly to sternum.	Probang.	3 weeks.	Cured.	.....	McKeown.
35	1879.	F., 30.	Lancet, Feb. 1, 1879, p. 155.	Piece of vulcanite tooth-plate one-half inch long by one-quarter inch broad.	Behind glottis, but disappeared by patient's own efforts to remove; pain at middle of gullet.	Attempts with forceps.	13 days.	Cured.	.....	Alexander.
36	1879.	F., 30.	.....	Malignant growth of the pharynx preventing the use of nourishment.	.....	.....	.....	Died.	.....	Puckard.

Of the above 36 cases of oesophagotomy, 27 recovered and 9 died. The operation was performed 32 times for the removal of foreign bodies, which in most instances were lodged at or near the pharyngo-oesophageal junction, and which had resisted the ordinary means for their extraction. Of the remaining 4 operations, 1 was done for the relief of stricture produced by swallowing a caustic alkali, 2 were on account of carcinoma, and 1 was in consequence of obstruction occasioned by the pressure of enlarged lymphatic glands. In 2 cases in which the gullet was opened for foreign bodies none were found.

Poisons taken into the Stomach, and their Treatment.

In those emergencies which arise from accidentally or intentionally taking poisons into the stomach the surgeon is often called upon suddenly to render professional aid.

These poisons may be briefly considered under the usual classification of mineral and vegetable.

Mineral Poisons.—The principal poisonous substances of this class are arsenic, corrosive sublimate, nitrate of silver, corrosive acids, as sulphuric, nitric, and muriatic, salts of copper or lead, and phosphorus. The symptoms which attend a poisonous dose of any of these articles are those of great gastric irritation, pain and distress, and, in the case of the mineral acids named, of violent irritation, swelling, and burning heat along the whole extent of the alimentary tract from the lips to the stomach.

TREATMENT.—The treatment is both antidotal and evacuating. The first is based on the chemical reactions of the substances swallowed,—the effort, in other words, to ally them with some material for which they are known to have a strong affinity, and their union with which results in the formation of an inert or harmless compound.

In the case of arsenic, the hydrated sesquioxide of iron, freely administered, converts the poison into an arsenate of iron, which is innocuous. Until this agent can be employed, milk, the white of eggs, or flour, which are almost always at hand, may be administered. Both in America and in Europe a very large proportion—three-fourths—of the cases of criminal poisoning are done with arsenic.

If the poison is corrosive sublimate, the white of eggs, milk, and the protosulphuret of iron will constitute the proper remedies. This preparation of mercury forms with albuminous compounds an albuminate of mercury.

Nitrate of silver is rendered inert by the use of common table-salt, the latter converting the salt into an insoluble chloride of silver. The poisonous effects following the use of the salts of copper are best counteracted by the white of eggs or albumen, and by calcined magnesia, and those resulting from the preparations of lead by the administration of alkaline sulphates, as sulphate of soda or magnesia, or by giving very dilute sulphuric acid, which changes the poison into the sulphate of lead. The precaution given by toxicologists in the treatment of poisoning from the carbonate of lead by the antidote named above is to use the dilute acid at short intervals, not continuously, as the evolution of carbonic acid which follows the use of the remedy might cause dangerous distention of the stomach.

In the case of poisoning by the mineral acids, the exhibition of alkalis will be indicated; and, with a view of soothing the mucous coat of that part of the alimentary tube above the stomach, and of shielding the stomach, sweet oil should be given.

Phosphorus when taken in poisonous quantities, as sometimes happens with children, who in their ignorance swallow the ends of matches, should be dislodged immediately from the stomach by emetics or by the stomach-pump. The antidote which seems to answer best is the sulphate of copper, which, in addition to possessing the property of an emetic, forms with the phosphorus, according to Bamberger, an insoluble compound.

Vegetable Poisons.—The vegetable poisons most frequently taken are opium, belladonna or atropia, strychnia, and oxalic acid.

SYMPTOMS.—The symptoms which characterize the poisonous action of narcotic principles derived from the vegetable kingdom are due to impressions made on the brain, on the spinal marrow, or on both, as manifested by vertigo, dimness of vision, stupor, stertorous breathing, convulsions, etc.

The poisonous effects of opium are best counteracted by washing out the

stomach with the stomach-pump, using at the same time fluid containing tannin or tannic acid. The patient must also be kept in motion or walking with the aid of an assistant on each side.

Atropia-poisoning is to be met with the free use of tannin and charcoal, at the same time employing emetics and the stomach-pump. Digitalis, coffee, camphor, and other cardiac stimulants may also be demanded.

Strychnine-poisoning is best counteracted by an emetic of sulphate of copper or zinc. Tannic acid should be administered, and when feasible the stomach-pump must be employed. In case of convulsions being present, the inhalation of chloroform, or the exhibition of chloral hydrate, will be indicated. In extreme cases artificial respiration must not be overlooked.

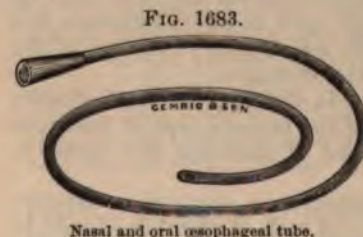
Oxalic acid, which is a very deadly vegetable poison, finds its best antidote in lime or powdered chalk, with which substances there is formed an insoluble oxalate of lime.

After the use of antidotes, and even before, in many cases, the employment of emetics in order to evacuate the stomach is exceedingly important. When these are administered immediately after the ingestion of the poison, the latter may often be dislodged from the viscus before any evil effects are experienced. The substances commonly in use for this purpose are powdered mustard, a large spoonful of which should be thrown into half a pint of lukewarm water and immediately drunk. Sulphate of zinc, from the promptness with which it induces emesis, is another valuable agent. Twenty grains dissolved in a wineglassful of water will produce the desired effect; or the same amount of ipecacuanha may be administered. All of these emetics should be assisted by irritating the fauces with a finger or a feather in order to hasten vomiting.

In many cases the reflex sensibility of the stomach has been so destroyed by the absorption of the poison into the system that it becomes necessary to remove its contents by the use of the stomach-pump, an instrument adapted not only to cases of gastric torpor, but also to most cases of poisoning by substances taken into the stomach.

The artificial introduction of fluids into the stomach, and the use of the stomach-pump.—In consequence of wounds of the pharynx and the œsophagus, or from the moods of the insane, it frequently becomes necessary to introduce nutritious fluids into the stomach by means of the œsophageal tube. In other instances, where poisons have been swallowed, either accidentally or designedly, it is required that the stomach should be promptly emptied of its contents. For effecting the first object, that is, the introduction of nourishment,

two methods can be employed, namely, by the syringe and by gravity. The tube (Fig. 1683) for conveying the liquids may be passed into the œsophagus through either the mouth or the nose. The latter is preferable, as the muscular resistance of the faucial muscles is thereby avoided. Sometimes, owing to deviation of the septum, or peculiar conformation of the nasal cavities, difficulty will be experienced in introducing the tube. When such is found to be the



Nasal and oral œsophageal tube.

case on one side, the other nasal passage should be tried. When the special tube is not at hand, a long No. 17 gum catheter may be conveniently extemporized for the purpose.

Operation by the syringe.—The patient being seated on a low stool or chair, with the head well thrown back, the surgeon introduces the elastic tube or soft catheter, previously well oiled, into the anterior meatus of one side of the nose, and, turning its point towards the floor of the nasal cavity, pushes it gently along the fossa until it reaches the pharynx, against the posterior wall of which it will sometimes become arrested. A little additional pressure will overcome the resistance, and the tube will continue to descend until it has passed into the œsophagus. If the instrument is used on account of a

wound of the latter, it is necessary to carry it some distance beyond the seat of the lesion. If no complication of this nature exists, and the object is solely to sustain animal life, the tube need not be carried more than one or two inches below the pharynx. While held in this position, the nozzle of a gum bag charged with the liquid aliment, or that of a Davidson's syringe (previously filled and afterwards supplied with the same material from a basin), is to be fitted into the tube, when the contents are to be gradually forced through the tube into the œsophagus. In the one case this is done by compressing the gum bag; in the other the bulb of the syringe is compressed with the fingers. The liquid must always be introduced slowly, in order not to distend the walls of the stomach suddenly; in other words, the natural manner of taking food should be followed.

Artificial alimentation by the gravity method consists in using a gum tube having at one end a large, funnel-shaped expansion for the reception of the liquid after the tube has been introduced into the œsophagus. The aliment is passed into the stomach by raising the funnel-shaped receptacle above the level of the pharynx. (Fig. 1684.)

Instrumental evacuation of the stomach.—For removing the contents of the stomach in case of poison being taken into the viscus, it is necessary to employ the stomach-pump. The apparatus with the necessary appliances consists, first, of the pump with its two branches, one at right angles to the other, and each supplied with a valve, opened or closed at pleasure by a lever; second, two gum tubes, one (long) for the stomach and the other (short) for the discharge and the supply of liquids; third, a wooden screw in order to force the jaws apart; and, last, a wooden ring for the double purpose of keeping the maxillæ asunder and the protection of the stomach-tube against the teeth. (Fig. 1685.)

The apparatus is expensive. A substitute for it is an ordinary metallic or hard rubber enema syringe of large size, with stop-cock and a stomach-tube.

OPERATION.—The patient sits on a low stool or chair, with the mouth kept open by the wooden or cork gag. The surgeon stands in front, and introduces, with the usual precautions, the long gum tube into the stomach; the syringe, charged with some bland or possibly neutralizing fluid, is fitted to the end of the tube, and its contents forced into the stomach. The next step is to withdraw the piston, in doing which the fluids of the stomach will be drawn into the barrel of the instrument. After closing the stop-cock and pushing home the piston, the contents of the syringe will be discharged into the basin, when, by repeating the process of opening the valve and withdrawing the piston, another installment of fluid can be removed. (Fig. 1686.) In this simple manner the stomach can be cleared of poisonous substances and its cavity washed out. When the stomach-tube is being withdrawn, the external orifice should be closed with the end of the thumb until the instrument has been entirely removed, in order to prevent any portion of its contents from entering the larynx.

There has been some difference of opinion as to the origin of the stomach-tube. Like many other inventions, its conception appears to have been the simultaneous product of two representative professional men, though living on opposite sides of the Atlantic. In 1797, Monro the younger, of Edin-

FIG. 1684.



Gravity apparatus for introducing aliment into the stomach.



Stomach-pump complete.

dence that these suggestions ever assumed any material shape, or were carried into effect. About the same time, and without any

FIG. 1686.



Evacuating the stomach by tube and syringe.

the thesis of Monro, a similar idea had occurred to Dr. P. only had the tube constructed, but as early as 1800 was

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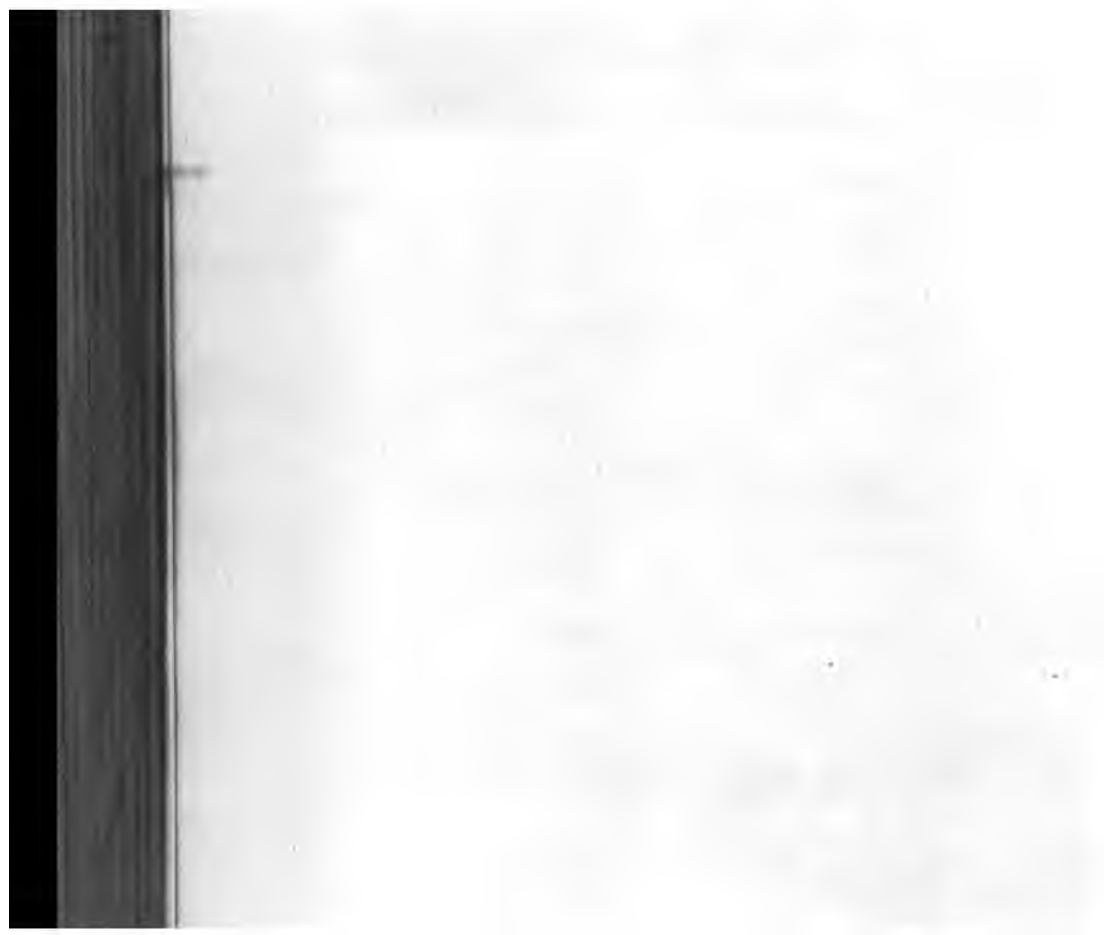
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